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ABSTRACT

Higher Education has experienced limited growth in recent years. Institutions, state commissions on higher education, and legislatures are faced with the prospect of providing educational services under steady-state conditions. Decisionmakers need to consider alternative means of providing educational services within resources available to the institution. Questions about the costs of these alternative means have become of critical significance. One important finding of costing studies conducted by the National Association of College and University Business Officers is that average historical full-cost per unit of service, representing the cost of past activities, is not a valid tool for projecting the cost of alternative courses of action. Historical or past cost only serves as a reference for making projections. Administrators wishing to project economic results must consider changes in conditions existing within the institution as well as changes in the environment that may affect the future use of institutional resources. This report describes the process of analyzing the behavior of costs and revenues in higher education. It is addressed to a broad cross-section of those involved in higher education, from the president, provost, business officer, and other senior administrators to governing boards, legislators, state commissions on higher education, the Department of Health, Education, and Welfare, and others responsible for allocating resources. (Author/MSE)

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NACUBO Professional File

# Cost Behavior Analysis For Planning in Higher Education

by Daniel D. Robinson, Howard W. Ray, and Frederick J. Turk

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## 1. *Cost Behavior in Higher Education*

Crucial questions face higher education concerning the use of scarce resources in the future. In the present economic environment, and for the foreseeable future, those institutions will remain strong which can either find new sources of support or systematically analyze and adapt their programs so as to use resources more effectively. If college and university administrators (as well as those in public office responsible for allocating scarce tax levy funds among competing institutions) are to respond appropriately to the individual and collective needs of higher education institutions, they must have improved tools for planning and managing resources.

The purpose of this report is to provide the higher education community with a basic understanding of one such planning tool — cost behavior analysis — and its role in the planning process. (Throughout this report, the term "cost behavior analysis" is intended to encompass revenue behavior wherever such a consideration is relevant.) The audience to which the report is addressed covers a broad cross section of higher education, from the president and other senior administrators to governing boards, legislators, state and federal bodies, and others responsible for allocating resources to higher education.

The report is not designed for the trained cost analyst but rather for those who must use the results of cost and revenue analysis in arriving at decisions. Therefore, it is not the intent of this study to present detailed procedures for performing cost behavior analysis, but rather to discuss the concepts underlying such procedures and their applicability to complex institutions of higher education.

The type of analysis described in the report is not new. Many commercial enterprises have used such methods in projecting their future operations. But the application of this tool in higher education is not widespread.

### *Applying Cost Behavior Analysis to Planning*

The focus of this study is on projecting cost behavior for planning. Planners need to know what costs to anticipate under a variety of assumptions so that rational choices among alternatives may be made.

The planning process is conducted from two perspectives, "strategic planning" and "operational planning." Strategic planning is performed by top-level administrators. It involves (1) identifying institutional missions, (2) setting goals and specific objectives, (3) defining feasible program alternatives, (4) examining the potential cost and revenue of feasible alternatives, and (5) selecting the appropriate course of action. Typically, strategic planning results in policy guidelines or parameters that serve to guide operational planning.

Operational planning frequently is developed from the "bottom up." Schools, divisions, or departments identify their program and financial needs within the guidelines established by top-level administrators. Operational planning involves preparing a projection of needs for three to five years. The first year of the projection is the detailed operating budget; the remaining years are summarized to present a forecast of long-range needs. The operational

*Funding for the study which resulted in this report was shared by NACUBO and Peat, Marwick, Mitchell & Co. The author wish to express appreciation to the NACUBO Costing Standards Committee, chaired by John L. Green, Jr., executive vice president, University of Miami. The committee provided guidance in formulating, conducting, and reviewing the results of the study. A number of other individuals in higher education also contributed comments and suggestions to the report. Vincent R. LoCascio of Peat, Marwick, Mitchell & Co. contributed to the preparation of Section 5 of the report. Of the authors, Frederick J. Turk is a manager of Peat, Marwick, Mitchell & Co. Daniel D. Robinson and Howard W. Ray are partners of the firm.*

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planning process is repeated each year and the planning period is rolled forward thus maintaining a multiyear planning horizon at all times.

Cost behavior analysis is used in both the strategic and operational planning processes. In strategic planning it provides information on the potential cost and revenue of feasible alternatives. In operational planning, it provides financial information required by administrators to examine alternatives available within established guidelines.

### *Using Cost Behavior Analysis in Different Planning Methods*

All too often the so-called planning process has been limited to a short-range incremental budgeting process. There is a tremendous difference between incremental budgeting and incremental costing. Incremental budgeting assumes a given base of operations and focuses on additions to that base. As a result, it deemphasizes the examination of alternatives. One also hears about so-called program budgeting or zero-based budgeting where one questions each program activity and rejustifies its continuance. This study presumes that the administrator wishes to or must examine alternatives. Regardless of whether one examines alternatives by using program budgeting or by using incremental budgeting the cost behavior analysis technique is the same. The difference is that in incremental budgeting only certain elements in the environment and volume changes are considered; decision factors are not considered. Goals, objectives, organizational structure, priorities, and policies are assumed to remain the same.

In recent times programming, planning, and budgeting systems; program accounting; and management by objectives have become widely used methods for managing future institutional affairs. The only relevant cost applicable to any of these methods is cost developed from cost behavior analysis. Historical average unit cost is not relevant.

### *The Institution and Its Activities*

Institutions of higher education have certain distinctive characteristics that influence cost behavior. It is necessary to understand these characteristics and their interrelationships before attempting to project cost behavior for planning purposes.

Educational services provided by institutions of higher education usually are classified into three functions — instruction, research, and public service. Although these classifications provide a means of neatly separating activities according to purpose, they are often inseparable in the context of the total educational process. Instruction is the process of exposing students to a common body of knowledge. Research involves a defined process of exploring and expanding the common body of knowledge. Public service is often an important adjunct activity to instruction and research in that it provides an opportunity to test and apply what has been learned or discovered while simultaneously providing benefits to the community at large.

All three functions — instruction, research, and public service — act together to produce an "educated student." Together they form the institution's educational program. Therefore, changes proposed for one function may require compensating changes in the others in order to maintain a viable program. This interrelationship often influences cost behavior such that changes in one function may not be isolated. Rather, consideration must also be given to the cost effects that will be experienced by the other functions. Moreover, because single activity may involve two functions, such as instruction and public service, there may be difficulty in separating the "common cost" incurred in this joint activity to determine the projected cost of both functions. Clearly, changes in the joint activity will affect both functions.

Often there are vast differences in the way the educational functions are conducted. Within an institution, differences in organizational levels, disciplines, and academic conventions result in a variety of approaches to education. Some differences are subtle while others are significant. These differences cause variations in cost behavior among seemingly like educational activities conducted by the institution. Similarly, when comparisons are made between institutions, it is necessary to understand the differences in their educational approaches if the cost projections being compared are to be meaningful.

The departmental organization of colleges and universities is characterized by unusual interrelationships, interdependencies, and interactions. Some departments primarily provide academic services to students majoring in programs offered by the department. Other academic departments are service departments providing instruction to students who must complete program requirements. Some academic departments serve only students registered in a single school or division. Other departments provide academic services to students registered in many schools or divisions within a university. Besides academic departments, various support departments serve educational programs. These variations in organization, function, scope, and approach to providing services significantly influence cost behavior.

Institutions of higher education constantly encounter shifts in student demand for service. From time to time, the popularity of certain programs changes: for instance, student interest shifts from the liberal arts to programs with a vocational emphasis and back again. Demand can change relatively quickly, and academic and support departments have difficulty in adjusting to the peaks and valleys of demand. When demand increases rapidly, it may be difficult to find qualified personnel; and when demand slackens, it may be difficult to reduce staff proportionately.

*(continued on page 5)*

## *Summary of Report*

Higher education has experienced limited growth in recent years. Institutions, state commissions on higher education, and legislatures are faced with the prospect of providing educational services under conditions referred to as "steady state." Now, more than ever before, decision makers need to consider alternative means of providing educational services within resources available to the institution. Questions about the cost of these alternative means have become of critical significance.

The National Association of College and University Business Officers (NACUBO), with the assistance of Peat, Marwick, Mitchell & Co., has been conducting studies on costing and the use of cost information in higher education. One important finding of these studies is that average historical full cost per *unit* of service, representing the cost of past activities, is not a valid tool for projecting the cost of *alternative* courses of action. Historical or past cost only serves as a reference for making projections. Administrators wishing to project economic results must consider changes in conditions existing within the institution as well as changes in the environment which may affect the future use of institutional resources.

This finding prompted the preparation of this report which is devoted to describing the process of analyzing the behavior of costs and revenues in higher education. The audience to which the report is addressed covers a broad cross section of those involved in higher education, from the president, provost, business officer, and other senior administrators to governing boards, legislators, state commissions on higher education, the Department of Health, Education, and Welfare, and others responsible for allocating resources.

### *Arriving at Decisions About the Future*

This report is not designed for the trained analyst who has broad experience in applying the relevant principles of managerial economics. Such persons will find the paper elementary, or at least less technically satisfying than they would like for purposes of actual application. The paper is intended rather for the layman who must use the results of cost and revenue analysis in arriving at decisions about the future. It should be emphasized that it is not the intent of this study to present detailed procedures for performing cost and revenue analysis. Such detailed descriptions as well as empirical research will possibly follow from this paper.

The type of analysis described in the report is not new. Many commercial enterprises have used cost behavior analysis in planning their future operations. The application of this planning tool in higher education, however, is not widespread at present. Until recently, historical average unit cost was considered an acceptable basis for projecting future cost. In fact, the National Commission on the Financing of Postsecondary Education characterized such unit cost data as being the most useful for administrators and policy makers both for historical accountability and for analyzing resource requirements.

The empirical evidence indicates that historical average unit cost is not at all a valid basis for projecting future cost when changes are expected in goals, objectives, policies, methods of providing service, volume, and environmental conditions. This fact is supported by authoritative literature on managerial economics published and accepted for decades. First, costs do not change in direct proportion to changes in the total number of units of service — that is, not all costs react proportionately to changes in volume. Furthermore, a multitude of policy decisions made by administrators and changes in environmental conditions can significantly influence the future behavior of cost. Clearly, projections based on historical average unit cost do not cope with these influences on future cost behavior.

### *Principal Concepts of the Report*

The principal concepts treated in this report are outlined below:

1. Cost behavior analysis is a necessary tool in rationally estimating the future economic consequences of various alternatives. When examining the economic consequences of many alternatives, administrators must consider the effect on revenue as well as on cost: the term "cost behavior analysis" as used hereafter is intended to include the study of the behavior of both costs and revenues.

2. Estimating future economic consequences encompasses two related activities:
   a. Determining the effect on cost of various alternative courses of action assuming there is no change in the volume of service performed.
   b. Determining the fixed and variable components of total cost for the alternative selected at different levels of volume.

*(continued on page 4)*

3. Alternative courses of action consist of changes in (a) goals, specific objectives, and programs, (b) policies, and (c) organizational structure.

4. The act of selecting and implementing a given alternative requires administrators to make certain specific decisions. These decisions influence future costs. Those acts that influence future cost behavior are referred to as "decision factors."

5. Environmental conditions that are beyond the control of the institution also influence cost behavior. Decision makers should consider possible changes in the environment, referred to as "environmental factors," when projecting cost behavior for alternatives.

6. For each alternative, cost can also behave differently depending on the projected level of volume of service (for example, projected student credit hours). This phenomenon is referred to as the "fixed or variable" nature of cost. Projections of cost behavior in fixed and variable terms are performed within a relevant range of volume and for a defined period of time.

7. Projections of cost can be made manually if only a few alternatives and factors influencing cost behavior are considered. As the number of alternatives and decision and environmental factors increase and become more complex, a computerized simulation model is useful.

8. Cost behavior analysis provides information on the economic consequences of alternatives. Non-economic information about programs, students, faculty, facilities and other considerations should also be examined when making decisions about the future.

These are the essential concepts that should be considered when examining the future economic consequences of alternative courses of action.

## TABLE OF CONTENTS

**Summary of Report . . . . 3**

**1. Cost Behavior in Higher Education . . . . 1**
Applying Cost Behavior Analysis to Planning . . . . 1
Using Cost Behavior Analyses in Different Planning Methods . . . . 2
The Institution and Its Activities . . . . 2
Major Influences on Cost Behavior . . . . 5
Methods of Cost Analysis . . . . 5
Institutional Versus Statewide Planning . . . . 6

**2. Forces Influencing Cost Behavior . . . . 7**
How Variable Cost Behaves . . . . 7
How Fixed Cost Behaves . . . . 8
How Mixed Cost Behaves . . . . 8
Limitations on Traditional Methods of Projection . . . . 9
Decision Factors . . . . 10
Environmental Factors . . . . 10

**3. Projections of Cost . . . . 10**
The Decision-Making Process . . . . 11
Overview of the Projection Process . . . . 11
Projections at Different Volume Levels . . . . 11
Projections of Alternative Courses of Action . . . . 13

**4. Cost Behavior Analysis for Decision Making . . . . 14**
Cost-Volume-Revenue Analysis . . . . 14
Differential Analysis . . . . 15

**5. Computerized Simulation Modeling . . . . 15**
How a Simulation Model Works . . . . 15
Variables . . . . 17
Relationships . . . . 17
Using the Model for Decision Making . . . . 18
Considerations in Buying or Developing a Simulation Model . . . . 18

**6. Future Costing Efforts . . . . 18**

**Appendixes**

A. Partial List of Examples of Decision Factors that Influence Cost Behavior . . . . 20
B. Partial List of Examples of Environmental Factors that Influence Cost Behavior . . . . 28
C. Projections at Different Volume Levels and Projections of Alternative Courses of Action . . . . 29
D. Projecting Mixed Cost and Revenue . . . . 38
E. Projecting Cost and Revenue for More Than One Department . . . . 42
F. Cost and Revenue Analysis . . . . 46
G. Bibliography . . . . 50

**Figures**

Figure 1 — Variable Cost — Computer Usage . . . . 8
Figure 2 — Fixed Cost — Department Chairperson . . . . 8
Figure 3 — Mixed Cost — Faculty Services . . . . 9
Figure 4 — The Projection Process . . . . 12
Figure 5 — Cost-Volume-Revenue Chart . . . . 14
Figure 6 — Simulation Model Computation Sequence . . . . 16
Figure 7 — Simplified Logic Flow of Simulation Model . . . . 17

*(continued from page 2)*

Variations among undergraduate, graduate, and doctoral programs also present certain difficulties when projecting cost. Undergraduate programs are usually conducted through organized classroom instruction. Graduate programs include classroom instruction but also require research and thesis preparation. For doctoral programs, the educational process is quite different. Classroom instruction is minimized whereas research and dissertation preparation activities are predominant. An effective doctoral program requires relevant research opportunities; often, teaching and research assistantships must be offered. The differences among these programs and their special requirements have a significant influence on cost behavior.

In addition to characteristics pertaining to educational processes there is one that relates to educational results. In essence, there is an inability to quantify, measure, and determine objectively either the amount, value, or effect of a given course of instruction, methodology, or approach. In manufacturing, the end product can be described in finite terms. Its physical characteristics are readily quantifiable. These characteristics are directly traceable to the process of manufacture itself: A car built with 3,000 pounds of steel is quite different from a car built with 4,000 pounds of steel, and its cost is also different.

In education, the "product" is not readily susceptible to physical description and quantification, and a direct correlation between the elements that go into the educational process and the results they produce is impossible to derive. There is no simple way to relate the input of resources to the output achieved.

Today marks the end of an almost unbroken upward trend of resource expansion and demand for services covering three decades. Tomorrow there is the likelihood of, at best, a steady state, or worse, a period of decline. Clearly, institutions of higher education need to reexamine and question virtually everything they do. New ways of doing things must be found which will enable colleges and universities to maintain and improve their effectiveness in the face of declining resources.

Higher education administrators need only observe their sister institutions to see examples of how many different alternatives are available for accomplishing similar objectives. Instructional programs, for example, can be conducted in a variety of ways, each of which has merit and advocates in one place or another. Changing from one method to another may have enormous economic consequences and simultaneously no perceivable difference in pedagogical result. The challenge is to change as the demands of society change. Many forces in higher education create a natural inertia which makes changes either unattractive or unattainable.

If administrators are to carry out their responsibilities in planning the most effective use of resources for the future, they must understand the forces that influence cost behavior and how they should be factored into the planning process. Equally important is the understanding of how this form of analytical inquiry differs from others and how and why its informational requirements are different.

### *Major Influences on Cost Behavior*

Cost behavior is influenced by three types of forces. These forces may be classified as environmental factors, volume factors, and decision factors. *Environmental factors* may be defined as conditions influencing cost behavior which exist in the social, economic, political, cultural, and physical milieu in which the institution operates but over which the institution has no substantial direct control. *Volume factors* relate to the behavior of cost in reaction to changes in volume within a defined range of activities or services for a given period of time. When cost increases or decreases proportionately to increases or decreases in volume, it is classified as variable. When cost remains the same in total regardless of changes in volume it is classified as fixed. Finally, when cost increases or decreases in an irregular pattern in relation to changes in volume, it is classified as mixed. The third influence on cost behavior — *decision factors* — may be defined as those specific attributes or elements of goals, objectives and programs, organizational structure, and operating policies which can be directly and substantially affected by decisions of administrators.

### *Methods of Cost Analysis*

Cost analysis involves examining and evaluating costs and related statistical information in order to determine the implications of past, present, and future actions. There are several ways of undertaking cost analysis.

*Full cost analysis* involves examining and evaluating the total cost (direct and indirect) attributable to a cost objective. This type of costing may be useful in establishing funding and pricing structures in higher education for such items as tuition and fees, appropriation requests, and recovery of grant and contract costs. It may also be used in examining and evaluating the historical cost performance of activities.

Until recently, many assumed that historical average unit cost was an acceptable basis for projecting future cost. The National Commission on the Financing of Postsecondary Education characterized such unit cost data as being most useful for administrators and policy makers both for historical accountability and for analyzing resource requirements. Were all the converging influences of environment, volume, and decisions to remain absolutely static, historical average unit cost information would be a useful device for projecting future requirements. Even a

casual review of history indicates that certainly in the last three decades such a steady state condition has been nonexistent nor is it likely to exist in the foreseeable future. Therefore, historical average unit cost is inappropriate for projecting future cost. This finding was one of the most important to emerge in recent studies of costing and the use of cost and revenue information in higher education, studies which have been conducted since 1974 by the Costing Standards Committee of the National Association of College and University Business Officers, assisted by Peat, Marwick, Mitchell & Co.[1]

To use historical average unit cost to project future cost is erroneous for two reasons:

1. *It does not reflect the effects of changes in service.* It assumes that all factors involved in providing a service (for example, faculty salary, ranks, contractual obligations, and methods of instruction) will continue as before. This is rarely the case in many institutions. Change frequently occurs, influencing the cost per unit of service and thereby affecting projections of cost.

2. *It does not reflect the effects of changes in volume.* It assumes that historical average cost per unit of service will remain the same for different levels of service volumes.

What is not considered in projections based on historical average unit cost is the fixed and variable nature of cost behavior. The assumption is that historical average cost per unit of service is entirely variable. Such assumptions will result in misleading projections. Historical cost information can provide only a point of reference for projections.

*Controllable cost analysis,* based on information normally derived from an institution's financial accounting records, involves the examination of those costs that are the assigned responsibility of the administrator of an organizational entity. Controllable costs are related to organizational entities so that accountability for use of resources is identified with an administrator. In controllable cost analysis, actual costs are compared to projected (budgeted) or standard costs to determine variances. If variances were caused by the actions of the administrator, it may be determined that the administrator should adjust subsequent expenditures to insure conformance to budgeted cost.

If variances resulted from circumstances beyond the administrator's control, the causes may be attributed to: (1) volume changes, such as an unanticipated increase or decrease in the actual number of students requiring room and board; (2) institutional policy decisions requiring a different type of service than originally intended; or (3) environmental effects on cost, such as that experienced with rapidly changing utility rates. Variances caused by these factors may necessitate an adjustment in the budgeted cost so as to establish a new level of controllable cost, which the administrator is responsible for achieving.

*Cost-volume-revenue* analysis relates the cost of service to the number of units of service provided and to the revenue derived from providing such service. This type of analysis presents the financial results anticipated for particular levels of activities or alternatives being considered. Emphasis is placed on examining cost, volume, and revenue, which can be different for alternative activities and for varying levels of units of service provided. Differential cost-revenue analysis (often referred to as incremental analysis) is a type of cost-volume-revenue analysis that is useful in making choices among alternatives. Differential costs and revenues are costs and revenues expected to change as a result of changes being considered in existing institutional activities.

The capital cost of owned buildings and equipment is not considered when analyzing future cost behavior. That portion of historical fully funded capital assets that may be assigned to a fiscal period is often referred to as "depreciation expense." Depreciation expense is irrelevant when projecting cost because it is a sunk cost that was incurred in the past.

On the other hand, capital costs anticipated in the future for new equipment, replacements, or for servicing debt on existing capital assets are relevant and should be considered when projecting future cost. This is one of the important characteristics that distinguishes cost-volume-revenue (and differential) cost analysis from full cost and controllable cost analysis that produce historical average unit cost information.

### *Institutional Versus Statewide Planning*

The planning process referred to in this paper relates to the activities that take place within institutions of higher education. Certainly, other groups have a vital interest in the planning process of higher education on a multi-institutional level. These would include such agencies as statewide "super boards," state coordinating councils, state departments of higher education, state budget officers, legislators, legislative analysts, and committees as well as federal agencies and the Congress. Many of these parties have concerns that are quantitatively and qualitatively different from those that pertain to institutions themselves. For instance, states are increasingly using formulas of one sort or another for allocating funds among colleges and universities that are supported in whole or in part from state tax levy sources.

[1] These studies included the presentation of a basic conceptual framework for costing in higher education in Administrative Service Chapter 4:5 "Fundamental Considerations for Determining Cost Information in Higher Education," which includes definitions of terms, descriptions of cost determination methods and approaches, and explanations of different cost analysis methods. Additionally, the committee evaluated the *Cost Analysis Manual (CAM)* and *Information Exchange Procedures, Cost Study Procedures (IEP)* prepared by the National Center for Higher Education Management Systems (NCHEMS) at the Western Interstate Commission on Higher Education (WICHE).

The types of decisions and hence the information required at the state level are substantially different from those needed at the institutional level. The use of cost information for planning at these supra-institutional levels is a subject that deserves a thoroughgoing treatment in its own right. Suffice it to say that there are two important conditions that need to be recognized at the state level: (1) because costs of instruction, research, and public service are not directly variable in relation to changes in the level of activity, colleges and universities need funding related to their individual pattern of cost behavior; and (2) there needs to be some kind of insulating factor that enables institutions of higher education to proceed with the business of instruction, research, and public service with a maximum of academic freedom while staying within the bounds of prudent fiscal management.

Legislators and others who use formulas for allocating resources among institutions tend to believe that the money appropriated will be used in exactly the same manner as the formula calculation is made. On the other hand, if institutions of higher education are to retain reasonable control over the development and execution of their educational programs, there is a need for the individual institution to maintain control over academic policies and programs so as to insure the intellectual integrity of these services.

## 2. *Forces Influencing Cost Behavior*

The ability to project cost and revenue depends on an understanding, first, of the way in which variable, fixed, and mixed costs will behave and, second, of how environmental factors and institutional decisions can affect that behavior.

Typically, cost behavior is examined for a specified time period and within a relevant range of level of service. Certain elements of cost which may be fixed in the short run (the next two- or three-year period for which projections are being made) may change their behavior and become variable or mixed beyond that time period. Similarly, costs may change their behavioral characteristics should projections be prepared beyond the predetermined relevant range of services being considered.

There are many determinants of whether costs are fixed, variable, or mixed. As indicated earlier, one determinant is their relationship to changes in volume — that is, how they respond to changes in the amount of goods or services provided. Other factors also affect behavior. These factors include (1) environmental factors which are external conditions beyond the control of institutions, such as inflation or population growth rates, and (2) decision factors which are actions that may be under the control of institutions, such as the ability to change tuition rates or to increase the present number of faculty or their salaries. These factors not only determine whether costs will be variable, fixed, or mixed, but also determine the economic significance of elements of future costs.

By classifying and analyzing cost behavior, administrators will gain important insights concerning the need for economic resources. They will understand the relationship of cost to various levels of service activity, and thus will learn what would happen to cost if service levels were to be changed. And they will learn how different variables influence cost. These kinds of insights into cost behavior are fundamental to intelligent management of resources and are common to most types of service and production activities. Yet this method of analysis has been all but ignored in the literature intended for the guidance of college and university administrators.

One can surmise probable reasons for this oversight. For example, many administrators have assumed that instructional cost varies directly with enrollment. For more than twenty years after World War II, cost appeared to behave in this way. This period was marked by almost uninterrupted increases in enrollment for most colleges and universities. When, in recent years, cost continued to rise while enrollment reached a plateau or declined, some observers began to see that the earlier correlations were coincidental rather than evidence of cause and effect.

Another reason why an analysis based on distinctions between variable and fixed costs may seem irrelevant to some educational administrators arises from the clouded relationship between educational processes and educational results. In education, the "product" is not readily susceptible to physical description and quantification, and a direct correlation between the elements that go into the educational processes and the results they produce is impossible to derive.

The answer to the dilemma of providing valid cost behavior information that can be used effectively in higher education lies in understanding two factors. First, cost behavior analysis in higher education focuses on educational *processes* as cost objectives, rather than on educational products. Second, educational decisions, rather than quantifiable physical properties, can change a given economic element.

### *How Variable Cost Behaves*

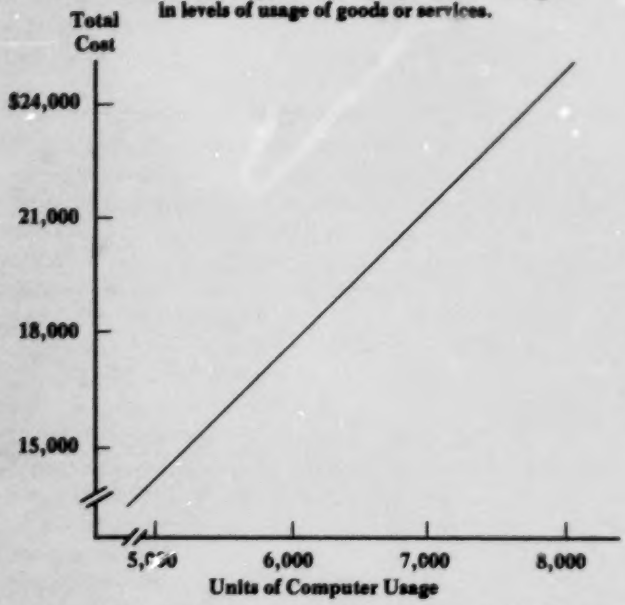
Variable cost fluctuates in total in direct proportion to changes in the level of activities or services. Variable cost might include student computer charges based on units of usage required according to the curriculum, paper supplies, duplication necessary to maintain student records, conduct tests, and record grades. In a given period of time, this cost would vary in direct proportion to the number of students receiving instruction in the department. Variable revenue in an academic department might include tuition received from students for each credit hour of instruction provided, or fees, such as laboratory fees, for services rendered.

Variable cost per unit is a constant which, when multiplied by the volume of service provided, determines total variable cost. As volume increases or decreases, total variable cost increases or decreases proportionately. This cost behavior pattern is displayed graphically in Figure 1, which illustrates the change in variable cost resulting from a change in units of computer usage. (Such a change could occur either from a change in the number of students using the computer or from a change in the required number of units that each student must use.) As the illustration shows, at each volume level, the total cost remains in proportion to units of usage, at a ratio of $3.00 per unit. Thus, 5,000 units of computer usage will cost $15,000 in total whereas 8,000 units of usage will cost $24,000. A similar behavior pattern would occur for variable revenue.

Figure 1

**Variable Cost—Computer Usage**

**Variable cost changes in direct proportion to changes in levels of usage of goods or services.**




It should be emphasized that the term "variable" refers to the proportional relationship of cost to changes in the number of units of service provided. A nonproportional change in cost is not considered variable (rather, it is considered mixed). This is the traditional definition of variable cost which is used extensively in the literature on the subject.

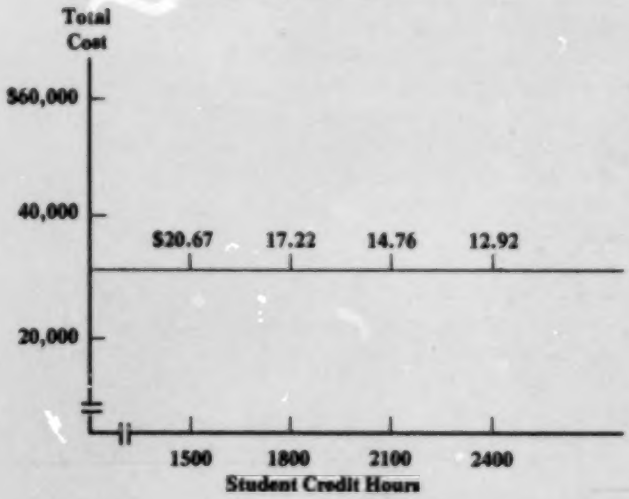
### *How Fixed Cost Behaves*

Fixed cost remains constant in total regardless of fluctuations in the level of activity or amount of services provided. A cost is fixed because it remains constant for a relevant range of activities or services over a given period of time. For this reason, fixed cost is often referred to as "capacity cost" — since it represents costs that are necessary to provide a range of service up to a certain maximum level. Fixed cost of an academic department might include, for a given period of time, the salary cost of the department chairperson, the dean's office, and fixed allocations of the cost of the president's office, registrar, admissions office, business office, and other university functions supporting the academic department.

Figure 2

**Fixed Cost—Department Chairperson**

**Fixed cost per unit will decrease as units of service increase, and vice versa.**




Because fixed cost is constant in total, the cost per unit of service provided varies inversely to increases or decreases in units of service. Thus, as units of service increase, fixed cost per unit of service decreases, and vice versa. This phenomenon is shown in Figure 2. Here, the department chairperson's salary, which is a fixed cost of $31,000, decreases from $20.67 per student credit hour (SCH) for 1,500 SCHs to $12.92 per SCH for a volume of 2,400 SCHs. Thus, the greater the volume of service provided, the less the fixed cost per unit of service.

### *How Mixed Cost Behaves*

Mixed cost is made up of both fixed and variable costs. Also referred to as "semivariable cost," mixed cost generally follows a stairstep behavior pattern. For a given level of service, cost is fixed. However, once a given threshold level of service is reached (assuming service is increased or decreased), cost changes.

The fixed component of mixed cost is required to provide a minimum level of service or is a constant because of contractual obligations or commitments. The variable component increases in response to changes in volume which have reached a threshold level, thereby requiring that additional cost be incurred. Mixed cost in an academic

department can best be illustrated by the cost of faculty. The faculty complement in a department may be composed of full professors, associate professors, assistant professors, and instructors. The complement includes tenured faculty and it may include nontenured faculty — those on annual appointments and part-time instructors.

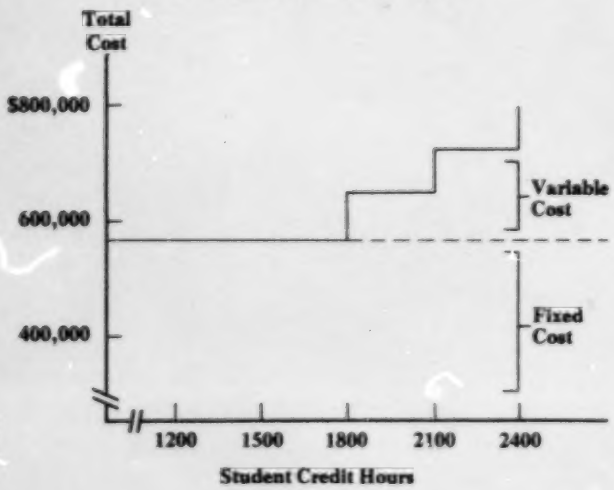
A basic complement of faculty is required to conduct an academic program regardless of shifts in student demand. However, those shifts can produce a change in the number of part-time or nontenured faculty. Faculty members with tenure or other contractual commitments represent a fixed base of cost which may not be changed except in extreme circumstances, whereas the cost of nontenured and part-time faculty is variable.

The behavior of mixed cost is illustrated in Figure 3. This illustration shows that the department has a fixed cost of $550,000. This fixed cost includes the salaries of tenured faculty as well as various fixed administrative and support costs. The fixed cost component of mixed cost remains constant. This level of cost provides the capacity to support 1,800 student credit hours of instruction. If student demand increases — that is, if additional SCHs are required — the department may decide to hire nontenured faculty to teach additional course sections. The salary cost of these nontenured faculty would increase the department's cost over and above its fixed cost in the following way: for each additional 300 student credit hours of instruction an additional nontenured faculty member would have to be hired. Thus the variable cost of the salaries of such faculty members would increase by the amount of salary at each additional 300 hours of instruction provided.

Figure 3

**Mixed Cost—Faculty Services**

**The fixed component of mixed cost remains constant regardless of changes in the level of service. The variable component increases in a stairstep pattern with increases in level of service.**




Should enrollment decline, this variable cost would also decline as nontenured faculty are let go; but again, once the threshold of 1,800 hours of instruction is reached no further cost reductions could be achieved because the balance of the department's cost is fixed; the number of faculty with tenure or contractual commitments cannot readily be reduced. (Fixed cost stemming from contractual commitments, such as the cost of tenured faculty, is referred to as "committed" cost.)

Although faculty cost is classified as mixed for purposes of illustration, this cost may also be wholly fixed or variable depending on the relevant range of services and period of time for which a projection is made. Environmental and decision factors may also influence this element (and other elements) of cost. For example, the compensation of a new faculty member to accommodate increased enrollment starts off as a variable cost. When the institution grants tenure, however, the compensation becomes a wholly fixed cost. Finally, at a later date, in the face of financial exigency or under other circumstances, the tenure condition may be overriden, thus changing the cost back to variable again.

The granting of tenure is one kind of educational decision that has received much attention, but there are many other educational decisions that have been largely unexamined and that have profound effects upon cost behavior over time. The following section describes this behavior in greater detail and illustrates how it responds to changes in institutional decisions as well as to the changing environment.

### *Limitations on Traditional Methods of Projection*

Thus far, costs have been classified according to variable, fixed, or mixed behavior in relation to changes in volume of service. This assumes that cost is exclusively a function of volume. But it is not. As indicated earlier, the end product of higher education is not measurable in quantitative or physical terms. Moreover, the ingredients of an instructional program, a research project, or a public service activity vary from one institution to another depending on the academic approaches to conducting these activities. The manner in which these activities are performed is often a matter of personal preference and choice exercised by faculty, department chairpersons, the provost, the president, or the governing board.

There is no generally accepted, all-encompassing methodology for carrying on instruction, research, public service, and other related activities in higher education. There are as many variations of educational experiences among and within institutions as there are faculty and administrators deciding how these academic activities should be conducted. Clearly, too, many other factors that are beyond the control of the institution, such as the state of the economy, can profoundly influence the many academic activities.

The unique characteristics of institutions of higher education play havoc with the traditional cost projection methodologies that focus on volume changes as the exclusive determinant of cost behavior. The decisions of individuals within higher education, as well as forces beyond their immediate control, influence how cost will react to volume. To project cost and revenue behavior accurately, one must be able to integrate the effect of these environmental and decision factors with such projections.

*Decision factors:* Decision factors represent actions that are directly controlled by the institution's governing board, administrators, and faculty. These actions cover the whole range of discretionary powers, including the ability to change institutional goals, policies, organizational structure, and procedures. Examples of decision factors are the following (detailed examples are shown in Appendix A):

- changes in program, course offerings, and degree requirements
- changes in the number of faculty
- changes in salary rates and ranges for faculty and staff
- changes in fringe benefits for faculty and staff
- changes in admissions standards for freshman students
- changes in the hours of operation of the library

Because decision factors are under the control of the institution, they are of primary concern when projecting future cost and revenues. Certain decisions may have short-run implications on the economic behavior of proposed institutional activities. For example, the effects of a decision to change the hours of operation of the library are reversible by making another decision to continue operations as before. Other decisions have long-term implications. A decision to increase admissions standards for entering freshmen to improve the quality of the instructional program may limit the number of students that can be accepted by the institution. Enrollment may decline, and tuition and fee revenue will decrease over the four-year period that these students are in attendance.

Decision factors may also change the behavior of a given element of cost and revenue in terms of whether it is variable, fixed, or mixed. If the institution decides to extend two-year contracts to faculty after two years of service, the salary of the affected faculty members will change from a variable cost to a fixed cost for a two-year period. A decision to reduce average class size from 18 to 16 may require offering additional sections; the cost of faculty might therefore change from a fixed cost to a mixed cost, with the addition of a variable cost for the additional faculty members required to teach new sections.

It should be noted that the administrative decisions of certain educational institutions may be the environmental conditions of others. For instance, in some state systems certain types of decision factors, such as determining the amount of employee benefits, may not be "decision factors" in the context of the institutions. In fact, these decisions may be outside the control of the entities for which the governing boards are responsible, as, for example, when the state determines the level of employee benefits.

*Environmental Factors:* Environmental conditions represent future external conditions under which proposed academic activities are to operate. Environmental conditions may be anticipated or predicted, and in some cases influenced, by an institution; but the ultimate determination of what these conditions will be is beyond the control of the institution. One example of an environmental condition is the "rate of inflation" which will tend to reflect the expected increase in cost per year. The institution will be affected by it and can exercise no control over it. Other examples of environmental conditions are the national rate of student college attendance patterns, the national pattern of giving to institutions of higher education, and the national pattern of percentage of students desiring housing where there is no university mandate that students live on campus. (Detailed listings of examples of environmental conditions appear in Appendix B.)

When attempting to project cost behavior, planners must consider how these external environmental factors will influence cost incurred and the economic significance of different courses of action. For instance, an assumption about the future rate of inflation will influence how one determines percentage increases or decreases of cost over time. Thus, it may be assumed that the cost of supplies and fuel will increase from year to year at a rate of 5 percent and 12 percent, respectively.

Assumptions about environmental conditions also affect the behavior of cost in terms of its variable, fixed, or mixed characteristics. The percentage of students desiring housing may be assumed to approximate a proportion of one to every three students registered. Therefore, this assumption determines that housing revenue is a variable revenue up to the number of available housing units and can be projected in direct proportion to the number of student registrations.

## 3. *Projections of Cost*

Projections of cost (and revenue where appropriate) are approximations of future economic consequences of an activity for a given period of time and under defined assumed conditions. Effective decision making rests on projections of future cost within an acceptable margin of error; absolute precision is neither intended nor necessary for deciding on a particular course of action. Rather, the decision maker seeks a reasonable approximation of future conditions.

### *The Decision-Making Process*

Decision making in higher education, as in other fields, requires selecting a course of action from among alternatives. Clearly, before an intelligent choice can be made, the economic and noneconomic consequences of each alternative must be estimated. An analysis of cost behavior can help in accurately assessing the economic consequences of any alternative plan, and it can be beneficial to the decision-making process.

The first ingredient in the process of decision making is the perception of a need for change. This perception may arise in any number of ways. Institutional administrators may be dissatisfied with how programs are being conducted or with the results of a particular activity, or they may have to solve a particular problem. They may be searching for better ways to provide services, ways of expanding or contracting services, or methods of continuing services at less cost. Whatever the circumstances, they are seeking a way to modify an activity.

To respond to this perceived need for change, planners and administrators attempt to identify feasible alternative courses of action. By reviewing the purposes, methods, and anticipated results of an action, they can select appropriate options.

Once these alternatives have been identified and defined in terms of objectives and scope, administrators must proceed to assess the short- and long-term economic impact of each of the proposed alternatives. Institutional administrators must be able to analyze how much a proposed action will cost and, when appropriate, how much revenue it will generate.

The decision-making process must also take into consideration those noneconomic factors that will influence the selection of appropriate alternatives. For example, administrators must examine how each proposed course of action will affect the institution's mission, goals, policies, structure, and operations.

The final step is the decision — the choice of a course of action — and the implementation of that decision. In many businesses that choice might be made on the basis of primarily economic consequences. But in higher education noneconomic consequences may outweigh the economic consequences. Moreover, because higher education does not create a "product" that can be described physically in terms of output, subjective judgments must be made about the benefits of each proposed alternative. In some instances, these judgments will prevail over the objective findings concerning economic consequences which cost behavior projections will yield.

In spite of these limitations on the uses of cost projections in decision making, such projections are nevertheless a critical part of planning for higher education and are part of the full array of analytical techniques that planners must have.

### *Overview of the Projection Process*

The projection process begins by identifying and defining the activity for which projections are to be made and the units of service to be provided by that activity. Once the activity has been defined the projection can take two forms. One form of projection relates cost to changes in the volume of units of service, which requires a method of determining the fixed, variable, and mixed behavior of cost at different levels of volume. The other form of projection involves examining alternative courses of action. Alternative courses of action consist of changes in (1) goals, specific objectives, and programs; (2) policies; and (3) organizational structure. The important ingredient in this type of projection is the consideration of the different decisions that the institution can make about the scope and content of services to be provided and the variations in environmental influences that will determine economic behavior.

To distinguish between these two projection processes is to simplify a complex interrelationship. Both forms of projection should be performed before an appropriate course of action is selected. Often, planners will examine the economic consequences of alternative activities at an assumed single level of volume; subsequently, they will test each alternative at different volume levels to determine how fixed and variable costs would react should volume be more or less than anticipated. Or, planners may want to examine a specific activity and the fixed and variable nature of its cost at different levels of assumed volume. Once this is done, they may decide to consider alternative ways of performing this activity and the effects that different environmental conditions might have on future economic results. They would then identify feasible alternatives to determine their expected economic consequences.

A schematic representation of the projection process appears as Figure 4. The illustration highlights the two separate but interrelated projection processes that are typically applied. A discussion of each process follows. (Appendixes C, D, and E contain detailed examples of these processes as they apply to academic departments and support departments.)

### *Projections at Different Volume Levels*

To project economic consequences at different levels of volume the analyst must first be able to segregate costs into variable, fixed, and mixed categories. Certain costs are clearly fixed — that is, for a given period of time they will remain constant regardless of changes in volume within a given range. Other costs are clearly variable — they have a proportional unit relationship to volume, again, within time and volume range constraints. Still other elements of cost are neither wholly fixed nor wholly variable, but appear to change irregularly in relation to volume. This mixed cost must be sorted into its fixed and variable components.

An appropriate volume base must be selected for making projections. The appropriate base is one that is most closely related to the behavior of the cost element being projected. Thus, if the cost of supplies varies directly with the projected number of students rather than with the projected number of student credit hours, the number of students should be used as the unit base for projecting the cost of supplies.

The organizational level at which the projection is made must be defined when making projections, because cost behavior may be different at different organizational levels. For instance, when projecting the cost of academic departments, computer costs incurred by the department may be directly variable with the number of units of service received by the department. This is because computer usage frequently is charged at a standard rate per unit of service. When projecting the costs of the computer department itself, its costs, in turn, will have components which are fixed, variable, and mixed.

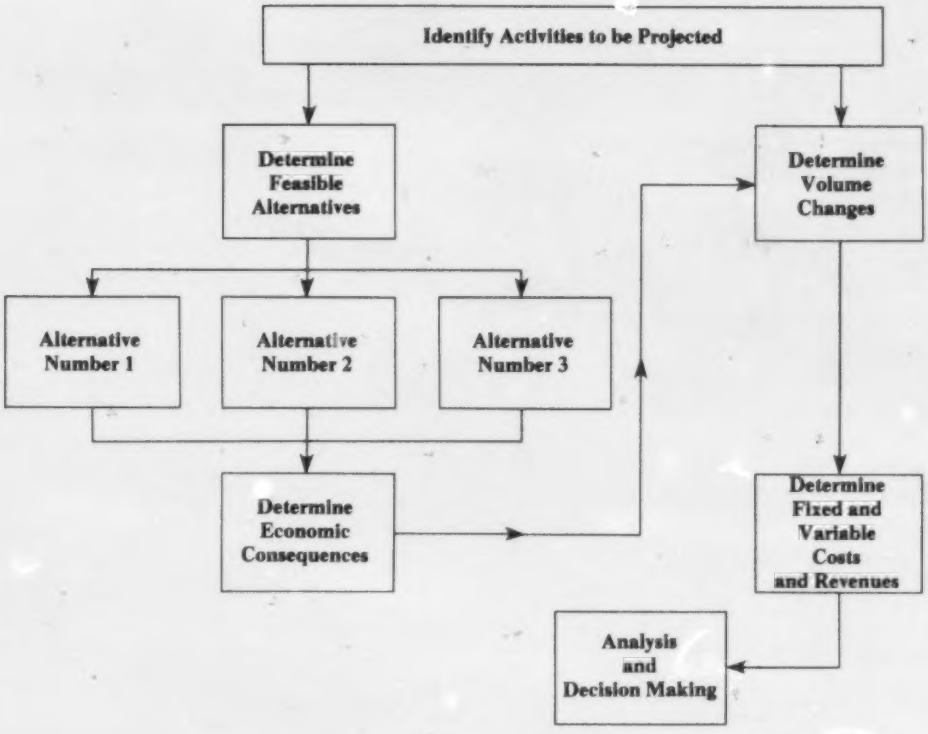
The segregation of cost into fixed, variable, and mixed categories is dependent on two projection parameters:

1. *Time.* For what period of time (two years, three years, etc.) is the projection being made? This determination is necessary to identify how various elements of cost will behave in the time period being considered. In the short run certain costs may be fixed, whereas in the long run they may become variable. This change in cost behavior is caused by changes in decisions which administrators can make in the future as well as by changes in environmental conditions. Under certain circumstances, it may be seen that in the short run all costs are fixed, whereas in the long run all costs are variable.

2. *Relevant Range of Service.* For what range of level of service is the projection being made? This determination is necessary to focus cost analysis efforts on the realistic levels of service that may be provided. More importantly, a determination of relevant range of service is necessary in predicting cost behavior. Projections of costs at either

**Figure 4**

**The Projection Process**



extreme, that is, beyond capacity or at zero, are irrelevant and of no practical use.

Once the projection parameters are defined, the cost analyst may proceed to project cost for one or more alternatives. If cost behavior analysis is being performed on an existing activity, the starting point in the projection process is to examine the existing table of organization, personnel, supplies, and other costs required to perform the activity. The table of organization represents existing commitments that must be considered should changes in volume of service occur in the future. For a new activity, the starting point is the minimum table of organization required to provide effective service (that is, the minimum organizational requirements at the lowest end of the range of service being considered). Each element of cost for the projected table of organization is examined. A determination is made of how these elements will behave in relation to changes in volume within the relevant range of service for the time period being projected.

Once identified, fixed or variable costs present little problem in the projection process. Mixed costs, however, present a problem, for the analyst must decide how to sort mixed cost into its fixed and variable components. This may be accomplished by examining historical cost behavior for the activity or similar activities or by making judgments about the behavior of mixed costs.

When examining historical cost behavior, the analyst may use a variety of methods for treating mixed cost:

1. *Assignment as fixed or variable by closest approximation.* In prior periods, certain mixed costs may appear to have remained constant or to have changed in relation to volume. Although not precise, the assumption can be made that mixed cost behavior is either fixed or variable. If assumed fixed, the amount projected will remain constant. If assumed variable, the variable cost per unit would be determined for all units of service provided in prior periods. This variable cost per unit would be used to project cost within the relevant range being considered.

2. *Application of the high-low method.* The high-low method attempts to separate cost of prior periods into fixed and variable components by assuming that cost at the lowest point at which units of service are provided is fixed and all cost above this point is variable. The fixed cost base plus the average cost per unit above the base would be used to project cost within the relevant range being considered.

3. *Use of least squares regression analysis.* The least squares regression method attempts to determine a line that represents the average of the relationship between the cost of prior periods and units of service provided. This average cost per unit would be used to project cost within the relevant range being considered.

Each of these methods relies on historical cost behavior as a basis of predicting future behavior of mixed costs. This reference to historical cost behavior should never be confused with the use of historical average unit cost data to project future costs. As indicated earlier, the average historical unit cost (regardless of how derived) is not a basis for projecting costs in the future. The error in using such data arises from the assumption that the average historical cost per unit of service is fully variable rather than consisting of fixed and variable components. Here, the point is that historical cost behavior may be useful in separating mixed cost after clearly fixed and clearly variable costs have been identified. (See Appendix D for a description of each of the above three methods.)

The methods of projecting mixed cost behavior based on historical relationships may be misleading and impractical — misleading because institutional decisions or environmental conditions cause the cost to behave differently, and impractical because certain activities for which projections are being made may lack historical precedent. What then should be done? The answer is neither self-evident nor simple. The analyst must examine the decision factors or environmental conditions that will influence mixed cost behavior in the future. For instance, if faculty cost were a mixed cost, the decision factors influencing its behavior in the future would be changes in course offerings, faculty rank, average salary, preferred section size, faculty workload, and the like. Mixed cost behavior, then, within the relevant range of service being considered would change accordingly depending on how these decision factors are changed.

### *Projections of Alternative Courses of Action*

To project the economic consequences of several courses of action, the characteristics of each alternative must be defined. For each alternative, planners must identify the resources required to provide a certain level of service. They must make informed judgments about the scope and content of service delivery and must consider how various proposed decisions as well as environmental factors may influence future cost behavior.

Once feasible alternatives have been defined, the rigorous process of developing cost projections begins. The initial projection begins at an assumed level of expected volume. Projected cost is determined for the period of time being considered. To arrive at these projections the analyst must consider the decision and environmental factors described earlier which affect cost behavior. For instance, one way to reduce cost might involve maintaining the past level of instruction, research, and public service but purposefully reducing the number of senior faculty in academic departments. This may be accomplished by substituting instructors for associate and full professors through early retirement. An alternative might be to increase class size or workload to eliminate instructor positions. The cost involved in the table of organization applicable to one alternative versus the other is quite different. Clearly, each alternative has important program-

matic as well as cost consequences which must be considered.

## 4. *Cost Behavior Analysis For Decision Making*

There are many methods for examining the possible consequences of decisions about the use of resources. The approcah selected is often a function of the cost analysis problem being considered. Two popular methods of cost analysis are cost-volume-revenue analysis, and differential cost and revenue analysis. A discussion of these analytical methods follows. (Illustrations applying these methods to typical problems of institutions of higher education are contained in Appendix F.)

### *Cost-Volume-Revenue Analysis*

Cost-volume-revenue analysis permits planners to examine how changes in volume will affect cost and revenue. This analysis relies on understanding the fixed, variable, and mixed nature of cost behavior.

The relationship of volume to cost and revenue is often portrayed on a cost-volume-revenue chart, which shows the fixed, variable, and mixed cost projections described earlier and the relationship of revenue and cost to volume at a single point in time. When preparing the chart, the analyst uses cost and revenue projections for a relevant range of volume. Projections of cost and revenue above or below the relevant range may behave differently.

The cost-volume-revenue chart has been used by business for many years. More recently some colleges and universities have applied the principles of cost-volume-revenue analysis to evaluate the economic consequences of alternative courses of action. An example of a cost-volume-revenue chart appears as Figure 5, which shows projections of the effects of increases or decreases in student enrollment on an institution's cost and revenue. The chart illustrates the points at which the number of students (volume) will result in either an overall *loss* to the institution, because the revenue from the students is less than the total cost of instruction, or a *gain*, because the revenue received is more than the total cost of instruction.

On the chart, revenue is presented as directly variable with volume. The analysis has assumed that revenue per student is constant over the relevant range of student demand for instructional services. Because of this assumption, the total revenue line is linear in relation to volume.

Cost is depicted as fixed and variable. Mixed cost has been separated into its fixed and variable components. Fixed cost remains constant in total for all levels of volume within the relevant range. Because the chart depicts the short-run relationship of cost to volume, most of the total cost is fixed. Variable cost per student is assumed to be the same over the relevant range of student demand being projected. Therefore, the total variable cost and the total cost line are linear in relation to volume.

By presenting the relationship of cost and revenue to different levels of volume, the analyst can also identify the point at which equilibrium between gain and loss is achieved. This point is often referred to as the "breakeven point." In the example, enrollment below 4,400 students indicates that the university is incurring a loss whereas enrollment above that point indicates a gain. This is because revenue per student is assumed to be constant while the cost per student will decrease as volume is increased (because fixed cost per student decreases as volume increases). Because of the high proportion of fixed cost to total costs at all levels of volume considered, there is an extreme leveraging effect as volume varies above and below the breakeven point.

This method of analysis assumes that the following conditions exist:

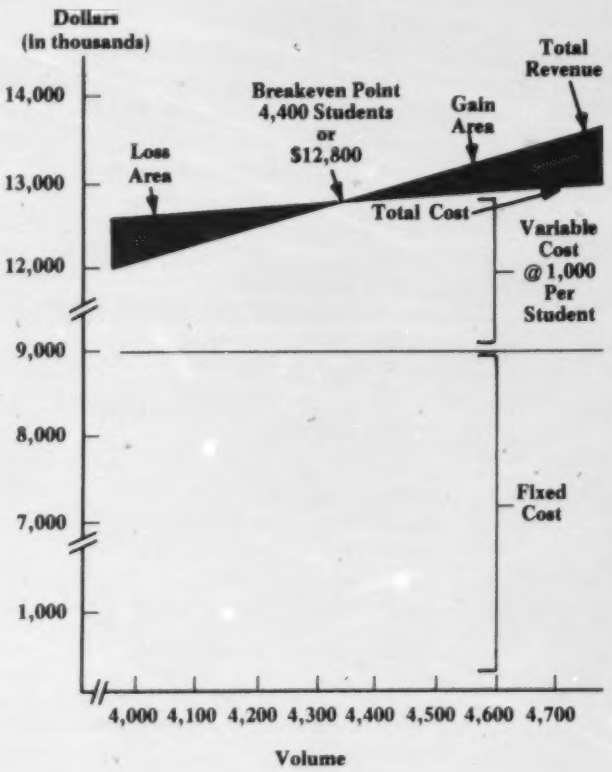
1. Cost can be identified as fixed or variable.

2. Fixed cost will be unchanged over the relevant range of volume being considered.

3. Variable cost will change proportionately to changes in the levels of volume being considered (within a relevant range).

**Figure 5**

**Cost-Volume-Revenue Chart**



4. Cost and revenue will follow a linear pattern over the relevant range of volume being considered.

5. Efficiency and productivity are to remain the same.

6. The major factor affecting cost and revenue is a change in volume.

These assumptions may not always be true. Projections of cost may not be as sophisticated or precise as desired. This may be caused by a variety of cost determination problems, such as difficulties in separating the cost of joint services and identifying methods of allocating cost, which by necessity are arbitrary.

Additionally, this analysis is two-dimensional — cost and revenue are shown in relation to volume. In the short run, this relationship may be most important because the largest part of total cost is fixed cost. In the long run, however, other factors may have a significant effect on cost and revenue behavior. Because colleges and universities operate under dynamic conditions, factors other than volume must be considered in analyzing cost and revenue behavior. These factors are decisions that can be made by the institution and changes in environmental conditions.

Planners and analysis must determine whether variations from the assumptions used in cost-volume-revenue analysis are likely to be significant enough to result in misleading data. Because this judgment is one of materiality, it must be made on a case-by-case basis rather than by applying a general rule. If it is determined that exceptions are material, a number of cost-volume-revenue projections may be required. Each projection is made assuming that one or more factors (decision or environmental) are changed. By using the cost-volume-revenue analysis tool in this manner, the planner and analyst are able to examine the potential economic consequences of variations of a single course of action within a relevant range of volume.

### *Differential Analysis*

Differential cost represents the change in total cost resulting from the addition, elimination, or modification of activities. Differential cost is called incremental cost when additional cost is anticipated; it is called escapable cost when a contraction in cost is projected because of retrenchment. Differential cost should not be confused with marginal cost, which is the added cost of providing one additional unit of service.

Differential analysis is a variation of cost-volume-revenue analysis. Differential analysis, however, focuses on those costs that will be changed should the course of action being considered be adopted. In terms of economic consequences, the costs that are relevant are only those costs that will be different as a result of the decision. The fact that other costs may be attributed to alternatives to arrive at full costs is unimportant in this particular decision-making process.

Differential analysis is most useful for comparing the economic benefits of one alternative with those of another. By comparing the differences in cost, educational planners and administrators can assess alternatives in terms of the significance of the net contribution to, or drain upon, institutional resources. Colleges and universities may use this type of analysis to examine a wide variety of courses of action such as changes in program, changes in the method of providing educational services, and variations in the level of service.

One of the principal requirements in differential analysis is to project differential cost for both the short and long run. Long-run differential costs must be projected to determine the full economic consequences of the variety of alternative courses of action being considered. (See Appendix F for examples of the application of differential analysis.)

## *5. Computerized Simulation Modeling*

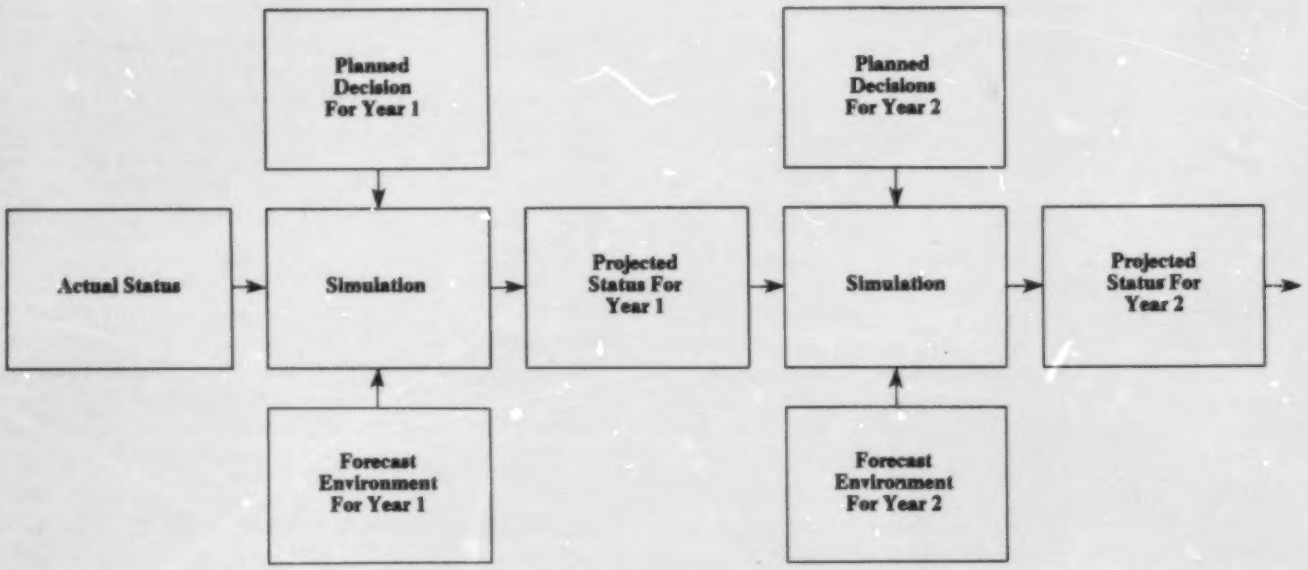
Cost and revenue behavior is primarily affected by decisions of top-level administrators. In institutions these decision makers are the governing board, the chancellor or president, provost and other senior administrators. Education commissioners and legislators act in a similar capacity at the state or federal level. Top-level decision makers are interested in examining the financial implications of potential changes in (1) goals, specific objectives, and programs; (2) policies; and (3) organizational structure. Evaluation of feasible alternatives before implementation is necessary to insure that resources will be used effectively.

The process of examining the economic implications of alternative courses of action at different levels of service may be achieved by simple manual calculation. Often, however, the alternatives are too complex to be examined without computer assistance. In such instances, a computer simulation model which is representative of the actual conditions being examined, may be used. Such a model is merely a tool designed to assist administrators in examining multiple alternatives and the economic consequences of changes in different levels of volume.

### *How a Simulation Model Works*

A model is any symbolic representation of a real system or process. A map is a good example of a model, but it is a static model: it represents a geographical area at only one point in time. A simulation model shows how a system changes. It shows not only the current state of the system but also how environmental and other forces change the system over time (see Figure 6). To transform a map into a simulation model, one would have to add all the influences that shape the geography — weather, earthquakes, meteors, etc. — and then project symbolically (perhaps

**Simulation Model Computation Sequence** **Figure 6**




through the use of overlays) how the area would look five, ten, fifty, or one hundred years from now.

A model must do more than indicate the general nature of the relationships between components of a system; the relationships must be precise. The information that Los Angeles is south of San Francisco and that New York is east of it does not help the traveler who wants to evaluate both trips in terms of duration, expense, or provisions required. Similarly any administrator knows that an increase in student body will result in increased facility and faculty requirements, increased tuition income and educational expense, and larger class sizes or more sections. What he or she needs, however, are specific measures of the effects of that increase in the student body and an indication of the decisions that can be made to accommodate those effects. An administrator will want to examine and experiment with various alternatives. The model, as a symbolic representation of the real system, provides a convenient means for performing this experimentation.

The framework for a model is composed of the major components in a system. In a college or university there are five major components: students; programs; faculty, staff, and other personnel; facilities; and finances. Organizationally, the college employs resources — faculty, staff, facilities, and finances — to support programs for students. In Figure 7, which illustrates this framework for a department providing instructional services, arrows show the primary causal relationships among the components. As indicated, students and programs "drive" the other components; that is, they are primary determinants of resource needs.

To identify what the educational system needs, the model must incorporate *quantitative* data on students and programs as well as on faculty, staff, facilities, and finances. The data may be of a summary nature, detailed only to the extent required for significant planning decisions. For example, individual students receive widely varying amounts of student aid, but the average amount per student is all the information needed for certain planning decisions. In broad terms, the types of information needed include the following:

- *Students.* Enrollment by division, major, and level, and average course load.
- *Programs.* Number of courses and sections by department, and section sizes by department.
- *Faculty.* Number of teachers by rank, and department and faculty workload.
- *Facilities.* Number of buildings, number and size of teaching stations, operating hours per day and facility utilization.
- *Finances.* Salaries, supply cost, and other expenditures, by department and revenues.

The information in the student component (average course load and enrollment by division, department, and level) combined with section-size policy by department (provided in the program component), would determine enrollment distribution and number of sections. The information on current faculty workload and on facilities may indicate teacher and facility requirements, including whether additional staff and facilities are required. The model then calculates financial needs based on decisions to meet staff needs (salaries, instructional supplies, etc.),

facility needs (construction, remodeling, maintenance, operations, etc.), and direct student and program considerations (instructional materials, direct federal or state funding, etc.).

Each of the five components contains the same basic types of items: variables and relationships between variables. Variables are those elements of the model that vary over time, such as number of students, revenues, and faculty pay scale. Relationships combine these variables into mathematical expressions that describe how changes in one variable produce changes in others.

### *Variables*

There are three types of variables: *state variables* — those that reflect the status of the educational system; *decision variables* — those that change the system's status and are controllable by administrators; and *environmental variables* — those that change the system but cannot be controlled by administrators.

A state variable reflects the state of affairs of a resource or a policy at a given time. Examples of resource state variables are enrollment, number of courses, size of faculty, teachers' salaries, and facility utilization. Policy state variables are any rules or guidelines that govern the manner in which resources are used. Examples of policy state variables are average student course load, average teacher workload, desired section size, and number of class hours per day.

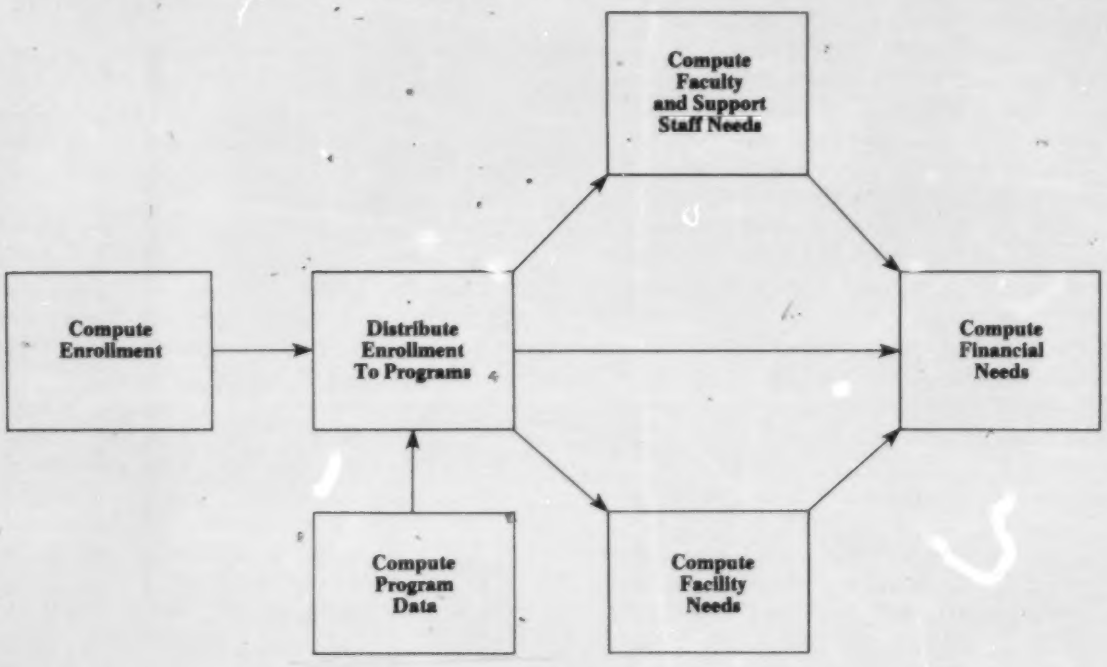
A decision variable is used to effect a change in a state variable. Decision variables that change resource levels to meet resource requirements — for example, changes in number of teachers, teachers' salaries, or number of buildings — are referred to as ad hoc decisions. Policy decisions change resource requirements and thus they have a broader effect than ad hoc decisions. For example, a change in number of periods per day changes classroom utilization; a change in desired section size changes demand for teachers and classrooms. A model should allow for the storing of a number of different sets of decisions that constitute plans for different contingencies.

Environmental variables are variables that are largely beyond control, but that have an impact on the educational system, such as rate of inflation. A number of different sets of environmental variables should be stored in the model. Storage of such information on contingencies permits the administrator to anticipate effects: "If this set of circumstances presents itself, we will make these decisions. If, however, this other set of circumstances arises, we will most likely counter with this other plan (set of decisions)."

### *Relationships*

State, decision, and environmental variables relate inextricably to one another so that a change in one may have primary and secondary effects on many of the others. It is the mathematical connection of all the variables into an integrated system that makes the model a model rather than simply an information system. Without a technique for expressing relationships, planners cannot use the data effectively.

**Simplified Logic Flow of Simulation Model** **Figure 7**



A simulation model uses two basic types of relationships: (1) those that project the future value of a state variable from a knowledge of its own current value and the decision and/or environmental variables acting upon it (intertemporal relationships); and (2) those that calculate the value of one state variable (dependent variable) from a knowledge of the values of other related state variables within a given year (intervariable relationships). Enrollment projections are a good example of how the intertemporal relationship functions. A model could automatically "promote" freshmen to sophomores, and sophomores to juniors, taking account of such factors as voluntary and academic attrition rates and transfers from other schools. Incoming freshman enrollment would be projected on the basis of number of applicants, number of applicants accepted, "no-show" probability of accepted students, and desired enrollment levels.

Once the model projects the future value for all independent state variables, intervariable relationships could then calculate the value of the dependent state variables for each year in the planning period. For example: student-faculty ratio (1976) = enrollment (1976) divided by size of faculty (1976). Another example would be total revenues (1976) = gifts from alumni (1976) plus revenues from government sources (1976) plus revenues from endowment funds (1976) plus other income (1976).

### *Using the Model for Decision Making*

A planning model is a tool. What tasks in the overall planning process should a model perform? What is the proper balance between user inputs and internal calculations and assumptions? Which variables should be treated as independent and which as dependent? These questions are highly interrelated. At one extreme, an analyst might attempt to use a model that would accept as input just one item, such as the number of incoming students, and project everything else internally. Such a model would require many internal assumptions about cause-and-effect relationships in the educational system. At the other extreme, an analyst might use a model that is nothing more than a complete data base (information system) from which to obtain key data, but with little, if any, internal logic to guide the decision-making process. Neither extreme is desirable. In the one case, the danger is that the model virtually takes over the decision-making process. In the second case, it provides insufficient assistance to an administrator.

A simulation model is designed to aid decision making. It does not make decisions; rather, it should display the impact of decisions so that users can see the implications of their plans and modify them appropriately. Through the use of simulation models, the planner has a means of greatly expanding the range of quickly available and informed alternative approaches to resource allocation.

### *Considerations in Buying or Developing a Simulation Model*

A computer simulation model can be a useful tool in the planning process. A model may be purchased (a number of models are commercially available) or developed to meet the unique needs of administrators. Before deciding to use a model, however, administrators should consider the following:

1. A planning model will be useful only if administrators are committed to a strategic planning process that focuses on alternatives, using, in part, quantitative analysis to support rational choices.

2. Planners should determine the proper balance between user inputs to a model and calculations and assumptions that are internal to a model. The more complex the internal calculations in the model, however, the more difficult to understand the results.

3. A model requires data from many sources within the institution. For the model to be a useful tool, this data must be accurate and timely. This requirement may require enhancement or development of administrative systems, a domino effect that can be costly.

4. Planners should determine how decisions resulting from the planning process will be implemented.

Although these considerations are not all-encompassing, they highlight the fact that the planning process is an administrative function. The model is a tool to assist administrators in planning. Clearly, the usefulness of the process and the tool is dependent on the commitment of administrators to reach planned goals and objectives.

## 6. *Future Costing Efforts*

The results of this study indicate that cost behavior analysis for planning is important in considering alternative means of providing educational services within resources available to the institution. Much remains to be accomplished before cost behavior analysis will be used extensively in higher education. The following efforts relating to cost behavior analysis should be undertaken:

1. *Workshops* exposing the results of this study should be shared with those interested in higher education. Selected individuals concerned with using cost behavior analysis should be invited. Such workshops could be held in each of the four NACUBO regions.

2. A *study* should be undertaken to determine where cost behavior analysis is being used for planning and how it may be applied elsewhere. This study would describe the organizational characteristics that should be in place if cost behavior analysis is to be used effectively.

3. *Empirical research* should be conducted to test the decision and environmental factors that influence cost behavior. The results of this research would be used to

identify factors that should be added or deleted from the listings presented in Appendixes A and B. Moreover, research should attempt to indicate the relative significance of various factors to the planner.

4. A *procedures manual* should be prepared to guide institutional administrators in performing the cost behavior analysis process. This manual should be made available to all institutional planners to assist them in preparing and analyzing cost projections.

The completion of these efforts will make a major contribution to unraveling the complexities inherent in the operations of institutions of higher education.

***(Appendixes A-G begin on page 20)***

**Professional File** *is a series of occasional papers published by the National Association of College and University Business Officers, on subjects related to the management of and accounting for financial and physical resources in higher education. The treatment may range from the conceptual to the practical. Views expressed are those of the authors; publication does not signify acceptance or endorsement by NACUBO. Copies of* Professional File *up to ten are available on request. Larger orders are available at a price based on 25¢ per copy for issues up to 24 pages in length, and 50¢ per copy for issues of 25 pages and over.*

## Appendix A

# Partial List of Examples of Decision Factors That Influence Cost Behavior

In attempting to estimate the costs and revenues that are likely to ensue from a future course of action, administrators must consider the interaction of three related forces, namely (1) volume of activity, (2) decision factors, and (3) environmental factors. The discussion in the text of this paper dealt with the effects of volume on cost behavior, focusing on the variable, fixed, and mixed components. This appendix identifies certain decision factors. (Appendix B describes certain environmental factors.)

Decision factors may be defined as those specific attributes or elements of goals, objectives and programs, organizational structure, and operating policies which can be directly affected by administrative decisions. Decision factors represent matters that administrators can control, either wholly or substantially. Decision factors are a characteristic concern arising from the development and evaluation of alternatives. Whenever administrators have hypothesized two or more courses of action, each course of action should be analyzed to determine the probable effect on cost behavior over various time periods, as the short-term effect may be quite different from that of the long term. Whatever the conditions, decision factors of each alternative must be specifically identified and their effect on cost behavior analyzed if administrators are to make sensible, realistic choices among alternatives.

Decision factors will vary depending upon the subject matter under study, the type of activity contemplated, and the organizational unit involved. Some decision factors will be so pervasive that virtually every part of the institution will be affected; others will have an impact on a limited number of subordinate units or programs. Some decision factors will engender a profound effect on future cost behavior; others may have an extensive influence on the very mission of the institution itself, but have no significant cost or revenue implications.

The table of decision factors, organizational entities, activities performed, and units of service which follows is believed to be the first such list of its kind. As such, the table does not purport to be complete. Moreover, the decision factors have not been ranked in any order of magnitude with regard to their relative impact on cost behavior. The material was presented in tabular manner with the thought that it would be a useful check list for the administrative planner. Other forms of presentation may also be useful. It is hoped that extensive empirical research will be conducted later that will both make successive tables more complete and indicate the relative cost behavior effect of each decision factor.

The table is structured to assist the user in understanding the activities performed, units of service provided, and decision factors that will affect many of the different types of organizational units or functions within an educational institution. The primary functions conducted by each entity are described under the heading "Activities Performed." The primary outputs provided by each entity are under the heading "Units of Service." "Decision Factors" are listed in relation to the organizational unit or function to which the factor seems most closely related. In a number of cases, of course, a single decision factor will affect cost behavior in more than one type of organizational unit or function.

Two important thoughts are intended to be reinforced by this tabular presentation. The first is that any decision factor has an explicitness about it which calls for quantification and correlation with organizational units through whom the decision will be implemented. The second is the simple reminder that much can be changed in almost every activity, and that it is the administrator's responsibility to consider alternatives and make choices, even difficult ones, if the institution is to survive in an increasingly difficult economic environment.

***Partial List of Examples of Decision Factors Affecting Cost Projections for Selected Organizational Entities***

| Organizational Entity | Activities Performed | Units of Service | Decision Factors* Description |
|---|---|---|---|
| **Instruction, Research, and Public Service Activities** | | | |
| 1. Divisions, schools, colleges, departments, institutes, centers, and individual projects | • Instruction, for credit<br>• Instruction, not for credit<br>• Individual or project research<br>• Public service<br>• Curriculum development<br>• Student counseling<br>• Departmental administration<br>• Administrative activities related to institution-wide operations<br>• Program development | • Student credit hours<br>• Student contact hours<br>• Number of courses and sections offered<br>• Number of research hours provided<br>• Number of research articles or papers published<br>• Number of public service activities by type or class<br>• Number of individuals served by public service<br>• Number of public service hours provided | 1. Determining the academic calendar<br>2. Setting tuition and fees<br>3. Determining the level of effort that should be devoted to obtaining gifts and grants<br>4. Setting public service activity fees<br>5. Establishing degree requirements<br>6. Defining interinstitutional cooperation activities (consortium)<br>7. Defining the level and content of programs<br>8. Deciding on the type of instruction (lectures, tutorial, etc.)<br>9. Determining course offerings<br>10. Approving section sizes<br>11. Defining grading policies<br>12. Determining the number and rank of faculty required<br>13. Defining faculty workload for:<br>• Instruction<br>• Research<br>• Public Service<br>• Released time for administration, curriculum development, etc.<br>14. Establishing faculty salary and staff rates<br>15. Determining methods of contracting with faculty<br>16. Determining faculty months of employment (9 vs. 12)<br>17. Setting promotion and tenure policy<br>18. Defining retirement policy<br>19. Defining recruitment policy<br>20. Setting sabbatical leave policy<br>21. Determining the level of support<br>22. Determining fringe benefits paid by the institution<br>23. Deciding on the level of effort to coordinate off-campus extended programs |

* This list of examples identifies decision factors having an influence on cost behavior of selected organizational entities. These decisions are not necessarily made by the entity itself. The locus of responsibility for such decisions varies from institution to institution.

| Organizational Entity<br>Selected Academic Support Activities | Activities Performed | Units of Service | Decision Factors*<br>Description |
|---|---|---|---|
| 2. Audiovisual Services | • Produce materials<br>• Select, utilize, and evaluate materials<br>• Provide classroom services<br>• Prepare tape recordings<br>• Provide projection services<br>• Maintain integrated media services<br>• Provide graphic services — graphs, charts, transparencies<br>• Provide in-house consulting services<br>• Acquire equipment and materials<br>• Maintain film holdings and provide film rental and distribution services | • Number of pieces of equipment loaned<br>• Number of pieces of equipment repaired<br>• Hours of television service<br>• Hours of utilization of multi-media facilities | 1. Determining the type of equipment required<br>2. Deciding whether to participate in programs requiring interinstitutional cooperation<br>3. Deciding whether services will be centralized or decentralized<br>4. Deciding to purchase or lease equipment<br>5. Deciding on the type of repair services provided internally versus that contracted<br>6. Identifying personnel skills required<br>7. Defining job responsibilities<br>8. Establishing personnel pay rates<br>9. Setting overtime policy<br>10. Determining supplies, film inventory and purchase requirements<br>11. Determining equipment needed to move and set up audiovisual materials<br>12. Establishing inhouse graphics capabilities<br>13. Establishing prices for services |
| 3. Academic Computing Support | • Provide computing capabilities as part of the instructional, research, and public service programs<br>• Provide computer-assisted instructional capabilities<br>• Provide information to academicians regarding student performance | • Number of students served<br>• Number of hours of computer time devoted to instruction, research, and public service | 1. Determining the type of equipment required<br>2. Deciding whether to participate in programs requiring interinstitutional cooperation<br>3. Deciding whether services will be centralized or decentralized<br>4. Developing software for instruction, research, and public service<br>5. Deciding to purchase or lease computer equipment<br>6. Identifying personnel required<br>7. Establishing personnel pay rates<br>8. Setting overtime policy<br>9. Setting policy for using institutional computing capability or contracting for services externally<br>10. Establishing prices for services |
| 4. Course and Curriculum Development | • Plan to improve academic programs<br>• Develop new program and course offerings<br>• Evaluate existing offerings to determine effectiveness<br>• Phase out or eliminate programs and/or offerings | • Number of full-time equivalent faculty devoted to course and curriculum development<br>• Number of hours<br>• Number of courses evaluated, added, modified, or eliminated | 1. Defining the type of organizational structure to be used (full-time, part-time, or committee)<br>2. Assigning personnel to this function<br>3. Setting the level of effort required and timetable for completion<br>4. Selecting external consultative assistance<br>5. Determining the amount of released time required to to perform these activities<br>6. Establishing personnel pay rates<br>7. Deciding on the consultant fees to be paid |

| Organizational Entity | Activities Performed | Units of Service | Decision Factors[a] Description |
|---|---|---|---|
| 5. Library | • Collect books, magazines, and other published materials<br>• Catalog materials<br>• Store and maintain the collection<br>• Lend materials<br>• Provide reference and research capabilities<br>• Maintain records of acquisitions, cataloging, circulation, etc.<br>• Teach library research and orientation courses<br>• Select materials related to curriculum and research | • Number of materials acquired including books, periodicals, microfilms, and manuscripts<br>• Number of materials cataloged<br>• Number of books circulated<br>• Number of times noncirculating materials are used<br>• Number of patrons using the library<br>• Number of times reference materials are used | 1. Determining library location (centralized vs. decentralized)<br>2. Deciding on hours of operation<br>3. Setting acquisition policy<br>4. Selecting fields of study requiring published materials<br>5. Establishing photocopying policy<br>6. Setting interlibrary loan policy<br>7. Setting library exhibit policy:<br>• Frequency<br>• Scope<br>• Stationary vs. traveling<br>8. Setting circulation policy<br>9. Determining binding requirements<br>10. Identifying personnel required<br>11. Establishing personnel pay rates<br>12. Determining late fines charge policy<br>13. Setting photocopying fee rates<br>14. Setting lost book fine rates<br>15. Determining the amount of book funds available |
| Selected Student Activities | | | |
| 6. Admissions Office | • Recruit and interview students<br>• Process applications<br>• Accept and orient students<br>• Prepare communications with students | • Number of applications received<br>• Number of students admitted<br>• Number of students interviewed<br>• Number of letters sent | 1. Determining personnel assignments to specific activities<br>2. Setting qualifications of students admitted<br>3. Defining preferred student characteristics<br>4. Defining acceptance procedures followed<br>5. Deciding on level of student recruitment effort<br>6. Selecting advertising media<br>7. Deciding to send letters of information to students after admittance<br>8. Identifying personnel skills required<br>9. Establishing personnel pay rates<br>10. Setting travel and entertainment policy for recruiting |
| 7. Counseling and Career Guidance | • Schedule student counseling sessions<br>• Student testing<br>• Advise students regarding course of study<br>• Student placement<br>• Disciplinary counseling | • Number of students counseled<br>• Number of tests given<br>• Number of employment interviews arranged | 1. Setting policy on frequency of counseling<br>2. Deciding on the type of tests given<br>3. Deciding on the level of effort in organizing employment interviews on or off campus<br>4. Identifying personnel skills required<br>5. Establishing personnel pay rates<br>6. Determining whether counseling and career guidance will be centralized or decentralized |

| Organizational Entity | Activities Performed | Units of Service | Decision Factors* Description |
|---|---|---|---|
| 8. Cultural Events | • Coordination of student body activities<br>• Cultural activities for student development<br>• Recreational activities and programs<br>• Specialized activities for segments of the student body<br>• Cultural activities for the community | • Number of student activities coordinated<br>• Number of events, lectures, etc. sponsored by the institution<br>• Number of hours of effort devoted to cultural events by type<br>• Number of students and nonstudents attending events | 1. Deciding on the level of effort involved in coordinating student body activities<br>2. Obtaining the resources required to support specific activities conducted for students including:<br>• Musical Events<br>• Lectures<br>• Publications<br>• Student Organizations<br>3. Identifying personnel skills required<br>4. Establishing personnel pay rates<br>5. Using professional consultants<br>6. Selecting performing arts companies<br>7. Contracting for professional exhibits<br>8. Deciding on the level of effort required to obtain gifts and grants supporting cultural events<br>9. Setting fees for admission to cultural events<br>10. Setting policy concerning availability of programs to nonstudents |
| 9. Dean of Students | • Coordinate student services activities<br>• Establish policies regarding counseling and career guidance, cultural events, health and infirmary services, men's and women's athletics, intramural housing, co-curricular programs and others<br>• Determine disciplinary action | • Number of hours devoted to administrative functions related to student services<br>• Number of hours devoted to specific types of student services<br>• Number of hours devoted to institution-wide activities | 1. Determining the number and scope of student services activities<br>2. Deciding on the level of effort required in coordination<br>3. Identifying personnel skills required<br>4. Establishing personnel pay rates<br>5. Determining contractual commitments |
| 10. Financial Aid Administration | • Determine student needs<br>• Identify potential sources of grants — internal and external<br>• Counsel students to develop appropriate aid package<br>• Administer work/study and other self-help activities<br>• Arrange and administer student loans | • Number of student applicants<br>• Number of students receiving financial aid counseling<br>• Number of students receiving grants<br>• Number of students receiving loans<br>• Number of students in work/study, etc.<br>• Number of students receiving financial aid by type | 1. Determining the amount of institutional grant money available<br>2. Determining the amount of institutional loan funds available<br>3. Deciding on the level of effort required to obtain external grant funds<br>4. Deciding on the level of effort required to obtain external loan funds<br>5. Determining the number of students for which a "needs analysis" is required<br>6. Determining the extent of external needs analysis assistance<br>7. Identifying personnel skills required<br>8. Establishing personnel pay rates<br>9. Determining internal systems and records required<br>10. Identifying internal reports required<br>11. Determining the frequency of loan billing |
| 11. Intramural Athletics | • Identify areas of student athletic interest<br>• Organize specific athletic programs<br>• Obtain facilities and equipment<br>• Coordinate athletic activities | • Number of students participating in intramural activities<br>• Number of hours devoted to organizing, coordinating, and performing other activities<br>• Number of athletic contests<br>• Number of students attending events | 1. Determining the number of athletic activities to be sponsored<br>2. Deciding on the facilities required<br>3. Deciding on the equipment required<br>4. Determining the level of supervision required<br>5. Identifying personnel skills required<br>6. Establishing personnel pay rates |

| Organizational Entity | Activities Performed | Units of Service | Decision Factors*<br>Description |
|---|---|---|---|
| 12. Intercollegiate Athletics | • Recruit student athletes<br>• Establish schedules<br>• Coach sports activities<br>• Obtain appropriate equipment<br>• Arrange for trainers, travel, officiating, etc., necessary for athletic events<br>• Coordinate athletic business affairs activities, including ticket preparation, ticket sales, advertising and promotion of athletic or specific events | • Number of student athletes<br>• Number of athletic events<br>• Number of tickets sold | 1. Deciding on the scope of recruitment effort<br>2. Deciding on the number of students on scholarship<br>3. Determining the items included in scholarship<br>4. Selecting coaches, trainers, and graduate assistants<br>5. Establishing personnel pay rates and perquisites<br>6. Setting ticket price policy<br>7. Establishing equipment purchase and replacement policy<br>8. Determining facility size:<br>• Present size<br>• Future expansion<br>9. Deciding on team size<br>10. Selecting nonconference opponents<br>11. Setting travel, meals, and lodging policy<br>12. Setting training policy |
| 13. Registrar | • Register students<br>• Process drop/adds<br>• Prepare class lists<br>• Collect grades<br>• Maintain student records<br>• Issue official transcripts<br>• Prepare reports | • Number of students registered<br>• Number of transcripts issued | 1. Determining the type of registration system used — automated vs. manual<br>2. Identifying personnel skills required<br>3. Establishing personnel pay rates<br>4. Determining the scope and frequency of reports<br>5. Deciding how student records will be maintained — automated vs. manual<br>6. Setting the number of terms (semester, trimester, quarter)<br>7. Deciding whether to centralize or decentralize registration<br>8. Setting policy on fines collection<br>9. Establishing the physical location of the bursar<br>10. Determining the timing and frequency of registration process:<br>• Preregistration<br>• Registration<br>• Late registration<br>11. Setting policy on deferred tuition payments<br>12. Setting policy on student file security |

| Organizational Entity<br>Selected Institutional Support Activities | Activities Performed | Units of Service | Decision Factors*<br>Description |
|---|---|---|---|
| 14. Business Office | • Assist in budget preparation<br>• Maintain financial accounting records<br>• Prepare financial reports<br>• Receive and deposit monies<br>• Collect monies receivable<br>• Pay monies due<br>• Manage auxiliary enterprises<br>• Direct plant operations and maintenance services<br>• Safeguard institutional assets<br>• Maintain nonacademic personnel records | • Number of transactions processed<br>• Number of man hours of service<br>• Number of drop/adds | 1. Selecting the type of financial systems used — automated vs. manual<br>2. Determining financial information required internally<br>3. Determining the number of accounts maintained<br>4. Identifying personnel skills required<br>5. Establishing personnel pay rates<br>6. Deciding on the scope and frequency of reports<br>7. Determining frequency of billings for receivables<br>8. Setting collection policies<br>9. Determining investment turnover policy<br>10. Setting purchasing/accounts payable policy and procedures:<br>• Design and frequency of requisitions<br>• Design and frequency of purchase orders<br>• Formal bidding requirements<br>• Use of purchase order vouchers and petty cash<br>11. Determining policy, procedures, and frequency of disbursements<br>12. Determining policy, procedures, and frequency of institutional payrolls |
| 15. Investment Office | • Analyze market trends<br>• Determine amount of monies available to invest<br>• Manage institutional investment portfolio<br>• Monitor performance of investments made by investment managers<br>• Meet with board of trustees to discuss investment policy and performance | • Number of investment transactions initiated<br>• Units in investment pool<br>• Units for evaluation of manager performance | 1. Selecting the type of system used — automated vs. manual<br>2. Determining financial information required<br>3. Deciding to use an investment pool<br>4. Determining the frequency of income distribution<br>5. Deciding to use investment managers<br>6. Identifying personnel skills required<br>7. Establishing personnel pay rates |
| 16. Development Office | • Plan approach for obtaining contributions<br>• Organize giving programs<br>• Develop alumni, friends, and others to give or to assist in obtaining contributions<br>• Meet with giving constituencies<br>• Prepare reports on performance | • Number of gifts received<br>• Number of proposals prepared<br>• Number of meetings held with giving constituencies<br>• Number of mailings | 1. Selecting the methods used to contact constituency<br>2. Deciding on the frequency of contacts<br>3. Deciding on the frequency and type of mailings<br>4. Determining the scope and design of development record-keeping systems<br>5. Identifying personnel skills required<br>6. Establishing personnel pay rates<br>7. Seeking assistance from administrators, faculty, board, alumni, and friends |

| Organizational Entity | Activities Performed | Units of Service | Decision Factors*<br>Description |
|---|---|---|---|
| 17. Operation and Maintenance of Plant | • Analyze plant operation and maintenance needs<br>• Organize services to include:<br>  ◦ Custodial services<br>  ◦ Building maintenance<br>  ◦ Care of grounds<br>  ◦ Utilities<br>  ◦ Property insurance<br>  ◦ Motor pool<br>  ◦ Fire protection<br>• Provide services on order or on a routine basis<br>• Assist in renovation of facilities | • Number of square feet cleaned or maintained<br>• Number of vehicles serviced<br>• Number of jobs<br>• Number of acres cared for<br>• Number of kilowatt hours used<br>• Number of BTUs furnished | 1. Setting policy on frequency of cleaning or maintenance<br>2. Determining use of subcontractors<br>3. Determining number of vehicles required<br>4. Deciding on the amount of utilities used<br>5. Deciding on the amount of insurance coverage required<br>6. Identifying personnel skills required<br>7. Establishing personnel pay rates |
| 18. Auxiliary Enterprises | • Provide food services to students and faculty<br>• Provide housing services<br>• Operate a bookstore | • Number of meals served<br>• Number of housing units filled<br>• Number of course books sold<br>• Number of general books sold<br>• Number general merchandise sales | 1. Determining whether auxiliaries will be operated at a loss, a profit, or break-even<br>2. Setting menu policy<br>3. Developing different meal plans<br>4. Setting policy on maintenance of housing facilities<br>5. Determining prices for food, housing, and bookstore items<br>6. Determining the amount of inventory required<br>7. Identifying personnel skills required<br>8. Establishing personnel pay rates<br>9. Setting free meal policy |

* This list of examples identifies decision factors having an influence on cost behavior of selected organizational entities. These decisions are not necessarily made by the entity itself. The locus of responsibility for such decisions varies from institution to institution.

**Appendix B**

# Partial List of Examples of Environmental Factors That Influence Cost Behavior

Environmental factors are one of the related forces that affect cost behavior. The others are volume of activity and decision factors.

Environmental factors may be defined as conditions in the social, economic, political, cultural, and physical milieu in which the institution operates but over which the institution has no direct control. In this respect they are almost the complete opposite of decision factors. The environmental factors of concern here are those which are likely to have a substantial effect on cost behavior.

Because environmental factors, by definition, cannot be changed by the institution, the institution must adapt to them if it is to survive. Although environmental factors cannot be predicted with certainty, administrators must make assumptions about future courses of events. Assumptions about likely trends or changes in environmental factors are an important ingredient in the planning process, and hence in the analysis of projected cost behavior.

Some environmental factors may have substantial consequences for future cost behavior. In those instances, the administrator would be well advised to test a preferred alternative course of action against two or more possible outcomes of such environmental factors. This testing of a plan for environmental sensitivity is roughly analogous to testing for the effect of changes in volume.

The following tabulation of environmental factors does not purport to be complete; it does indicate some of those factors which experience has shown to be significant in their impact upon cost behavior. Assumptions about each environmental factor should be made in terms of its relative rate and direction of change from the present. The environmental factors are:

- The total pattern of giving nationally to higher education.
- The level of corporate and foundation giving to higher education.
- The national level of alumni giving.
- The level of categorical support for research by source available to higher education.
- The level of general support from governmental bodies and others.
- The level of support for student aid programs from federal, state, local, and private sources.
- The amount of overhead recovery available by source.
- The national average income earned on investments.
- The national average income earned on short-term investments.
- The geographical location of alumni, friends, and others to be contacted for giving.
- The changes in state, local, and national tax legislation affecting gifts and contributions.
- The policies of statewide coordinating bodies.
- The college-age population of students.
- The national and regional rate of students accepting offers to attend institutions of higher education.
- The number of college-going students attending institutions in the region.
- The rate of adult students attending degree and nondegree programs in the region.
- The national attrition rate.
- The national and regional change in level of tuition and fees.
- The availability in the region of qualified personnel to work in institutions of higher education.
- The competitive regional personnel pay rates.
- The prices for external support services.
- Rate of obsolescence of computer technology.
- The market prices for computer equipment.
- The regional interest in fostering interinstitutional library cooperation.
- The national rate of thefts and loss of library books.
- The national trend of students selecting majors.
- The national or regional trend of students requesting financial aid.
- The national level of students dropping and adding courses.
- The regional level of students and nonstudents attending cultural events.
- The availability and type of off-campus cultural activities.
- The trend in governmental and other requirements for special systems, records, and reports.
- Changes in athletic conference or NCAA regulations regarding:
  - Recruiting
  - Number of events
  - Conference sharing of television revenues
  - Coaches
  - Scholarship limitations
- The level of competing sporting event prices.
- The national average income earned on investments.
- The rate of inflation.
- The Consumer Price Index.
- The rates charged by utilities.
- The expected climatic conditions.
- The rates charged by insurance companies.
- The state of local labor market affecting the availability of different skills and wage levels.
- Government ordinances and regulations requiring changes in physical plant.
- Government ordinances and regulations applicable to social action programs.

Appendix C

# Projections at Different Volume Levels and Projections of Alternative Courses of Action

Projections of cost can take two forms. One form involves making projections at different volume levels. The other form of projection holds volume constant while examining alternative courses of action. Such projections consider the effect that changes in decisions and in environmental conditions have on cost behavior. A discussion of each projection process follows for academic departments and support departments.

## *Projections of Academic Department Activities*

The head of an academic department, in consultation with the provost, has decided that the qualifications of entering students should be raised to improve the quality of the department's program. Both administrators realize that such an action would affect enrollment, with economic implications for future cost and revenue. To test the possible effects of this action on future departmental cost and revenue, they decide to project cost and revenue for different levels of enrollment. Once this projection is completed, they consider a number of alternative ways of providing instructional services.

### *Projections at Different Volume Levels*

To make a projection of economic consequences at different levels of volume — in this case different levels of student enrollment — the decision maker must first be able to segregate cost and revenue into variable, fixed, and mixed categories.

Certain of the department's costs are clearly fixed, that is, they will remain constant for a given period of time regardless of changes in volume. Other costs are clearly variable: they have a proportional unit relationship to volume. Still other elements of cost appear to change irregularly in relation to volume. This mixed cost must be sorted into its fixed and variable components. Any one or combination of the following methods, among others, may be used to separate the components of mixed cost:

1. Assignment as fixed or variable by closest approximation
2. Application of the high-low method
3. Use of least squares regression analysis

A description and illustrations of how these methods are used are provided in Appendix D. Once the variable portion has been identified, projections can be made based on increases or decreases in volume (that is, in units of service).

An appropriate volume base must be selected for making projections. The appropriate base is the one that is most closely related to the behavior of the cost element being projected. Thus, if tuition income varies directly with the projected number of student credit hours rather than with the number of full-time equivalent students, then credit hours, rather than student head count, should be used as the unit base for making projections.

In the following illustration, projections are separated into two groups: salary and other departmental costs. It is assumed that all changes in the methods of providing services and in the environment are to remain constant. Additionally, it is assumed that departmental administration, separately budgeted research, sponsored research, and other activities will not change. The only changes that will be considered are variations in student demand for instructional services.

The department currently has 19 faculty members who provide instruction, conduct research, and perform other departmental functions. The budget for the department is shown in Figure C1, which includes certain factors, such as faculty by rank and average salary by rank, in the department. The activities of the faculty are presented in the chart below, which also shows other factors affecting department operations, such as student enrollment, preferred section size, and faculty workload.

| Function | Students Enrolled in Courses | SCHs | Pref. Section Size | No. of Sections Req'd.[1] | No. of Faculty[2] @8 Per | Faculty: Professor | Faculty: Assoc. Prof. | Faculty: Asst. Prof | Faculty: Instructors |
|---|---|---|---|---|---|---|---|---|---|
| Instruction: | | | | | | | | | |
| Freshmen | 640 | 1,920 | 20 | 32 | 4 | | 1 | 1 | 2 |
| Sophomores | 480 | 1,440 | 20 | 24 | 3 | | 1 | 1 | 1 |
| Juniors | 360 | 1,080 | 15 | 24 | 3 | 2 | 1 | | |
| Seniors | 240 | 720 | 15 | 16 | 2 | 1 | 1 | | |
| | 1,720 | 5,160 | | 96 | 12 | 3 | 4 | 2 | 3 |
| Departmental Administration | | | | | 1 | 1 | | | |
| Separately Budgeted Research | | | | | 1 | | 1 | | |
| Sponsored Research | | | | | 4 | 1 | 2 | | 1 |
| Other (Curriculum Development, etc.) | | | | | 1 | | 1 | | |
| Total | | | | | 19 | 5 | 8 | 2 | 4 |

*Notes:*

[1] Rounded to nearest section.

[2] Faculty workload 24 credits per year or 8 sections (3 credits per section).

### *Salary Projections*

Projection of departmental salary cost is a three-step process. First, the head of the department determines the number of faculty that would be required at different levels of student demand. This determination is made by the following formulas:

$$\frac{\text{Projected SCH}}{\text{Average section size}^{[1]} \times 3 \text{ credits per section}} = \text{Number of sections to be taught}$$

$$\frac{\text{Number of sections to be taught}}{\text{Faculty workload}^{[2]}} = \text{Number of faculty required for instruction}$$

The results of these calculations are as follows:

| Total SCHs | Lower Division[1]: SCHs | Lower Division[1]: No. Sections | Lower Division[1]: No.[2] Faculty | Upper Division[1]: SCHs | Upper Division[1]: No. Sections | Upper Division[1]: No.[2] Faculty | Total Instructional Faculty Required |
|---|---|---|---|---|---|---|---|
| 5,160* | 3,360 | 56 | 7 | 1,800 | 40 | 5 | 12 |
| 2,640 | 1,920 | 32 | 4 | 720 | 16 | 2 | 6 |
| 3,480 | 2,400 | 40 | 5 | 1,080 | 24 | 3 | 8 |
| 4,320 | 2,880 | 48 | 6 | 1,440 | 32 | 4 | 10 |
| 6,000 | 3,840 | 64 | 8 | 2,160 | 48 | 6 | 14 |
| 6,840 | 4,320 | 72 | 9 | 2,520 | 56 | 7 | 16 |

*Notes:*

* Present number of student credit hours.

[1] Average section size: lower division 20, upper division 15.

[2] Faculty workload is 8 sections per year.

Second, the chairperson determines how faculty by level would be added or removed consistent with changes in student demand, separating those faculty members that should be considered fixed (F) because of tenure or contractual commitments from those that should be considered variable (V). The results of this separation are arrayed as follows:

| Total SCHs | Total Instructional Faculty Required | Professor[1] | | Associate Professor[2] | | Assistant Professor[3] | | Instructor[4] | |
|---|---|---|---|---|---|---|---|---|---|
| | | *F* | *V* | *F* | *V* | *F* | *V* | *F* | *V* |
| 5,160 | 12 | 3 | | 4 | | 1 | 1 | | 3 |
| 2,640 | 6 | 3 | | 3 | | | | | |
| 3,480 | 8 | 3 | | 4 | | 1 | | | |
| 4,320 | 10 | 3 | | 4 | | 1 | 1 | | 1 |
| 6,000 | 14 | 3 | | 4 | | 1 | 3 | | 3 |
| 6,840 | 16 | 3 | | 4 | | 1 | 4 | | 4 |

*Notes:*

[1] All professors are tenured.

[2] All associate professors and one assistant professor are under two-year contracts.

[3] All assistant professors but one (see Note 2 above) have one-year contracts. Therefore, contractual commitments to assistant professors are subject to change annually.

[4] All instructors are part-time.

Finally, a determination of projected cost is calculated for the various levels of units of service (SCHs) provided. This projection of cost is shown on Figure C2.

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### *Other Departmental Costs*

To project other departmental costs, the chairperson first identifies those costs that are fixed or variable, and separates the fixed and variable components of mixed cost using the methods referred to earlier and illustrated in Appendix D.

Based on the analysis of other departmental costs, each element of cost is projected as follows:

| | |
|---|---|
| Secretaries | —One secretary up to 3,480 SCHs<br>—At 4,320 SCHs add another, and at 6,840 SCHs add still another. |
| Fringe benefits | —At the institutional rate of 20 percent of salary |
| Computer cost | —At \$3 per unit of usage. Upper division students use approximately 12 units per year. |
| Supplies | —At \$2.50 per student |
| Duplication | —At \$1 per student |
| Equipment (instructional) | —At \$100 per faculty member instructing students |
| Computer cost for noninstructional activities | —Assume that this remains constant |

The results of these projections at various levels of volume (SCHs) are shown in Figure C3.

### *Departmental Revenue*

Departmental revenue is composed of three items: tuition; sponsored research-direct cost reimbursement; and sponsored research-indirect cost reimbursement. Tuition revenue is directly variable with the number of student credit hours of instruction at a rate of \$90 per SCH. Sponsored research-direct cost reimbursement is fixed revenue representing reimbursement of cost up to that ceiling specified by agreement with the granting agency. Sponsored research-indirect cost reimbursement is directly variable with salary cost at a rate of 5 cents on the dollar. Five percent represents that portion of indirect cost reimbursement applicable to departmental administration included in the indirect cost pool.

### *Projection Results*

The results of the projections of cost and revenue appear in Figure C3. When projected departmental cost is compared with revenue, the net remaining represents the contribution from departmental activities to support administrative cost. If a negative contribution is projected, other resources will be required to finance the department's operations.

### *Projections of Alternative Courses of Action*

To project the economic consequences of several courses of action, the characteristics of each alternative must be defined. Administrators must identify, for each alternative,

the resources required to provide a certain level of service and the anticipated revenue to be earned. They must make informed judgments about the scope and content of service delivery, and must consider how various proposed decisions will determine future cost and revenue behavior. They should also consider how environmental factors will influence future cost and revenue. (Detailed lists of examples of such decision and environmental factors appear in Appendixes A and B, respectively.)

If, in the case of the department discussed above, the chairperson and provost assumed that student demand would remain at 5,160 SCHs they might consider a number of actions to permit cost reductions, including changing the rank of faculty required for instruction. One alternative might be to initiate the retirement of one professor and to terminate the employment of an associate professor, replacing these faculty with two full-time instructors. This decision would have the following influence on departmental salary cost:

| | Current Status at 5,160 SCHs | | Proposed Status at 5,160 SCHs | |
|---|---|---|---|---|
| | *No. of Faculty* | *Cost* | *No. of Faculty* | *Cost* |
| Professors @ $28,000 | 3 | $ 84,000 | 2 | $ 56,000 |
| Associate Professors @ $22,000 | 4 | 88,000 | 3 | 66,000 |
| Assistant Professors @ $16,000 | 2 | 32,000 | 2 | 32,000 |
| Instructors @ $12,000 | 3 | 36,000 | 5 | 60,000 |
| Total | 12 | $240,000 | 12 | $214,000 |
| Change in salary cost if proposed decision is implemented | | $26,000 savings | | |

If the related fringe benefits were added to this, the total projected savings would be $31,200. This is only one of many possible alternatives that the department might consider in examining what its future cost and revenue may be.

## *Projections of Support Department Activities*

The process of projecting support department cost and revenue is not unlike that for academic departments. Again, the attempt is to separate cost and revenue into fixed, variable, and mixed components. The process of projecting a support department's cost and revenue might be illustrated by the admissions office of a university.

The director of admissions and the provost anticipate a curtailment in certain admissions activities in future years. They expect a decline in the number of applications which may have an effect on the number of students admitted. They decide to examine how the future cost and revenue of the admissions office would be affected by each of a number of different volume levels (that is, by different number of student applications). The admissions office budget is currently as follows:

| | No. | Budget |
|---|---|---|
| **Revenue:** | | |
| Application Fees (2,000 @ $25) | | $ 50,000 |
| **Cost:** | | |
| *Personnel:* | | |
| Director of Admissions | 1 | $ 23,000 |
| Assistant to the Director | 1 | 19,000 |
| Associate Directors | 2 | 32,000 |
| Clerical Staff | 2 | 20,000 |
| Secretaries | 3 | 27,000 |
| Subtotal | 9 | 121,000 |
| *Other:* | | |
| Fringe Benefits @ 20 percent | | 24,200 |
| Travel | | 13,000 |
| Advertising and Promotion | | 15,000 |
| Supplies | | 3,000 |
| Equipment | | 1,000 |
| Subtotal | | 56,200 |
| Total | | $177,200 |

### *Projections at Different Volume Levels*

To segregate cost and revenue into variable, fixed, and mixed categories, the reaction of different costs and revenues to change in volume must be analyzed. Based on the analysis of past cost and revenue behavior, the admissions director determines that the unit-of-service volume base that should be used for projection is the number of student applications received. To test expected cost and revenue behavior, the director decides to examine each of the following student application volume levels: 1,800, 1,500, and 1,200 applications.

In this example of a support department, the projection is separated into three groups: professional salary; clerical staff and secretarial salary; and other departmental costs.

#### *Professional Salary Projections*

The salaries of all four professionals are a fixed cost in relation to the number of applications received; the cost of these individuals would remain the same regardless of shifts or changes in volume within the relevant range.

#### *Clerical Staff and Secretarial Salary Projections*

Clerical staff are two full-time employees whose salary cost will continue regardless of changes in the number of applications within the relevant range. On the other hand, secretarial cost is a mixed cost: one secretary is employed full-time at $9,000, whereas the other two are hourly employees. Their responsibilities include processing applications, orienting students, and preparing letters and other materials. Analysis of historical cost behavior (by the methods described in Appendix D) indicates that the cost of the two hourly employees approaches true variability at a rate of $9 per application.

#### *Other Departmental Costs*

An analysis of other departmental cost behavior indicates that the following relationships should be employed to project cost:

| | |
|---|---|
| Fringe Benefits | —At the institutional rate of 20 percent |
| Travel | —At a rate of $6.50 per application |
| Advertising and Promotion | —Fixed cost |
| Supplies | —Mixed cost with $1,000 fixed and the remainder variable at $1 per application |
| Equipment | —Fixed cost |

### *Departmental Revenue*

Departmental revenue includes processing fees received with applications. This fee is directly variable with the number of applications received. The rates applied to applications are as follows:

| | |
|---|---|
| Applications received | $25 per application |

### *Projection Results*

The results of the projection process for the levels of volume indicated appear in Figure C4.

### *Projections of Alternative Courses of Action*

Certain support department activities relate to services provided to students or faculty once or twice a year in relation to the academic calendar. Because these services are cyclical in nature, analysis of historical cost and revenue to volume statistics may not provide a meaningful measure of variable cost or revenue per unit to be used for projecting future economic consequences. Moreover, many cost and revenue elements in these support departments are fixed, variable, or mixed depending on environmental and decision factors affecting the scope and level of service to be provided in the future. Thus, for such support departments it may be necessary to identify what these factors are likely to be before projecting the support department's cost and revenue.

Decisions regarding the scope and level of the activities of the admissions department, for example, can dramatically influence its cost. The activities of the admissions office include recruiting and interviewing students, processing applications, accepting and orienting students, communications with students, and advertising. In projecting the cost of the admissions function in an institution, consideration must be given to how these activities will be carried out.

A budget for the admissions activities appears as Figure C5. It indicates the status of different factors such as personnel, salary rates, fringe benefit rates, and other expenses of the department. This budget is based on the typical job responsibilities and emphasis is given to past admissions activities. Now, however, because of financial stringencies facing the institution, consideration is being given to modifying one of the admissions activities: the off-campus recruiting process. A recent study indicated that a large proportion of qualified student applicants have come to the institution regardless of the extremely active off-campus recruiting process. Thus the department is being asked to consider reducing this activity.

To determine the cost behavior that might be expected by making this policy decision, the admissions director analyzed the factors in the recruiting and interviewing activity. This analysis revealed the following findings:

1. The assistant director is expected to spend 50 percent of his time in recruiting.
2. The two associate directors are planning to spend 80 percent of their time in performing this function.
3. The recruitment and interviewing process is expected to require 50 percent of the time of one clerical staff member.
4. Travel costs for recruiting and interviewing are as follows:

| | |
|---|---|
| Ten trips to selected eastern cities at $200 per trip | $2,000 |
| Eight trips to cities and towns in the surrounding region at $75 per trip | 600 |
| Twelve circuit trips to various cities in the West, Midwest and South at $700 per trip | 8,400 |
| Forty local high school visits at $30 per visit | 1,200 |
| Off-Campus Cost | $12,200 |
| Out-of-pocket expenses for visiting students | 800 |
| | $13,000 |

Based on this analysis it was decided to consider eliminating the 50 percent effort of the assistant director in off-campus recruiting and similarly reducing the effort of one of the associate directors to 40 percent. This move would appear to save $9,500 of salary cost for the assistant director and $6,400 ($16,000 x 80% ÷ 2) for the associate director, for a total salary cost savings of $15,900. This would not be the case, however, because these individuals are full-time employees who are also performing other activities which must continue.

Since recruiting and interviewing activities are reduced, the excess time and related cost savings may only be achieved by eliminating one position in the admissions function. One assistant director position was selected for elimination. The associate director was assigned to perform the administrative activities formerly carried on by the assistant director. The personnel and related savings applicable to this policy decision are as follows:

| | |
|---|---|
| Assistant director | $19,000 |
| Fringe benefits (20 percent) | 3,800 |
| | $22,800 |

In addition to personnel reassignments and reductions, the twelve circuit trips were reduced to four and trips to selected eastern cities were eliminated. This policy decision reduced projected cost as follows:

| | |
|---|---|
| Ten eastern city trips | $2,000 |
| Twelve trips reduced to four, at $700 per trip | 5,600 |
| | $7,600 |

The projected cost savings resulting from these decisions are expected to approximate $30,400. This illustration of the cost projection process points out that the historical relationship of cost (and revenue) to applications received is not a useful guide to an understanding of the effects on cost resulting from fundamental decisions.

### *Projections of Activities of More Than One Department*

The projection processes described above focus on the procedures and effects of projections within a single department or office. However, for certain alternative courses of action under consideration, the institution may need to adopt a broader perspective, examining the effects of changes in decisions on the costs and revenues on more than one department. For example, changes in student demand in one department can have multiple cost implications for other departments. If one department decides to open sections or to add courses because of increased demand, another department may be forced to close sections and eliminate courses. Appendix E includes an examination of the ways in which the institution can consider effects of decisions, or of changes in the environment, upon more than one department.

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**Model Department Budget** **Figure C1**

Fiscal Year 1976-77

| | Average Salary | Number | *Functions* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Instruction | Separately Budgeted Research | Sponsored Research | Other | Department Administration | Total |
| Professors | $28,000 | 5 | $ 84,000 | $ — | $ 28,000 | $ — | $28,000 | $140,000 |
| Associate Professors | 22,000 | 8 | 88,000 | 22,000 | 44,000 | 22,000 | — | 176,000 |
| Assistant Professors | 16,000 | 2 | 32,000 | — | — | — | — | 32,000 |
| Instructors | 12,000 | 4 | 36,000 | — | 12,000 | — | — | 48,000 |
| Subtotal | | 19 | 240,000 | 22,000 | 84,000 | 22,000 | 28,000 | 396,000 |
| Secretary | | 2 | — | — | — | — | 16,000 | 16,000 |
| Subtotal | | | 240,000 | 22,000 | 84,000 | 22,000 | 44,000 | 412,000 |
| Fringe Benefits | 20% | | 48,000 | 4,400 | 16,800 | 4,400 | 8,800 | 82,400 |
| Computer Costs | | | 21,600 | — | 9,000 | — | 400 | 31,000 |
| Supplies | | | 4,300 | 800 | 2,800 | — | — | 7,900 |
| Duplication | | | 1,720 | 1,080 | 4,200 | — | — | 7,000 |
| Equipment | | | 1,200 | — | 3,200 | — | — | 4,400 |
| Total | | | $316,820 | $28,280 | $120,000 | $26,400 | $53,200 | $544,700 |

**Projected Salary Cost**
Fiscal Year 1977-78

| *Function* | | *2640 SCHs* | | *3480 SCHs* | | *4320 SCHs* | | *5160 SCHs* | | *6000 SCHs* | | *6840 SCHs* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instruction: | | No. of Faculty | Cost | No. of Faculty | Cost | No. of Faculty | Cost | No. of Faculty | Cost | No. of Faculty | Cost | No. of Faculty | Cost |
| Professors @ $28,000 | F | 3 | $ 84,000 | 3 | $ 84,000 | 3 | $ 84,000 | 3 | $ 84,000 | 3 | $ 84,000 | 3 | $ 84,000 |
| | V | – | — | – | — | – | — | – | — | – | — | – | — |
| Associate Professors @ $22,000 | F | 3 | 66,000 | 4 | 88,000 | 4 | 88,000 | 4 | 88,000 | 4 | 88,000 | 4 | 88,000 |
| | V | – | — | – | — | – | — | – | — | – | — | – | — |
| Assistant Professors @ $16,000 | F | – | — | 1 | 16,000 | 1 | 16,000 | 1 | 16,000 | 1 | 16,000 | 1 | 16,000 |
| | V | – | — | – | — | 1 | 16,000 | 1 | 16,000 | 3 | 48,000 | 4 | 64,000 |
| Instructors @ $12,000 | F | – | — | – | — | – | — | – | — | – | — | – | — |
| | V | – | — | – | — | 1 | 12,000 | 3 | 36,000 | 3 | 36,000 | 4 | 48,000 |
| Subtotal | | 6 | 150,000 | 8 | 188,000 | 10 | 216,000 | 12 | 240,000 | 14 | 272,000 | 16 | 300,000 |
| Departmental Administration | | 1 | 28,000 | 1 | 28,000 | 1 | 28,000 | 1 | 28,000 | 1 | 28,000 | 1 | 28,000 |
| Separately Budgeted Research | | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 |
| Sponsored Research | | 4 | 84,000 | 4 | 84,000 | 4 | 84,000 | 4 | 84,000 | 4 | 84,000 | 4 | 84,000 |
| Other (curriculum development and others) | | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 | 1 | 22,000 |
| Subtotal | | 7 | 156,000 | 7 | 156,000 | 7 | 156,000 | 7 | 156,000 | 7 | 156,000 | 7 | 156,000 |
| Unassigned faculty with contracts | | | | | | | | | | | | | |
| Associate Professors | | 1 | 22,000 | – | — | – | — | – | — | – | — | – | — |
| Assistant Professors | | 1 | 16,000 | – | — | – | — | – | — | – | — | – | — |
| Total Faculty Cost | | 15 | $344,000 | 15 | $344,000 | 17 | $372,000 | 19 | $396,000 | 21 | $428,000 | 23 | $456,000 |

Figure C2

**Projected Total Department Cost and Revenue**

Fiscal Year 1977-78

| *Cost* | 2640 SCHs | 3480 SCHs | 4320 SCHs | 5160 SCHs | 6000 SCHs | 6840 SCHs |
|---|---|---|---|---|---|---|
| Faculty | $ 344,000 | $ 344,000 | $ 372,000 | $396,000 | $428,000 | $456,000 |
| Secretary | 8,000 | 8,000 | 16,000 | 16,000 | 16,000 | 24,000 |
| Subtotal | 352,000 | 352,000 | 388,000 | 412,000 | 444,000 | 480,000 |
| Fringe Benefits 20% | 70,400 | 70,400 | 77,600 | 82,400 | 88,800 | 96,000 |
| Computer Costs (U. Div. student headcount×12×3) | 8,640 | 12,960 | 17,280 | 21,600 | 25,920 | 30,240 |
| Supplies (2.50×total student headcount) | 2,200 | 2,900 | 3,600 | 4,300 | 5,000 | 5,700 |
| Duplication (1.00×total student headcount) | 880 | 1,160 | 1,440 | 1,720 | 2,000 | 2,280 |
| Equipment | 600 | 800 | 1,000 | 1,200 | 1,400 | 1,600 |
| Computer costs, supplies, etc. for: | | | | | | |
| Separately budgeted research | 1,880 | 1,880 | 1,880 | 1,880 | 1,880 | 1,880 |
| Sponsored research | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 |
| Department administration | 400 | 400 | 400 | 400 | 400 | 400 |
| Total Cost | 456,200 | 461,700 | 510,400 | 544,700 | 588,600 | 637,300 |
| ***Revenue*** | | | | | | |
| Tuition Revenue @90 per SCH | 237,600 | 313,200 | 388,800 | 464,400 | 540,000 | 615,600 |
| Sponsored Research: | | | | | | |
| Direct cost reimbursement | 103,200 | 103,200 | 103,200 | 103,200 | 103,200 | 103,200 |
| Indirect cost reimbursement (5%)[1] | 4,200 | 4,200 | 4,200 | 4,200 | 4,200 | 4,200 |
| Total Revenue | 345,000 | 420,600 | 496,200 | 571,800 | 647,400 | 723,000 |
| Net contributions to institutional and support costs | $(111,200) | $ (41,100) | $ (14,200) | $ 27,100 | $ 58,800 | $ 85,700 |

[1] Represents that portion of indirect cost reimbursement applicable to departmental administration in the indirect cost pool.



Figure C3

**Projected Total Admissions Department Cost and Revenue**

Fiscal Year 1977-78

| | 2,000 Applications | 1,800 Applications | 1,500 Applications | 1,200 Applications |
|---|---|---|---|---|
| ***Cost*** | | | | |
| Personnel | | | | |
| Director of Admissions | $ 23,000 | $ 23,000 | $ 23,000 | $ 23,000 |
| Assistant to the Director | 19,000 | 19,000 | 19,000 | 19,000 |
| Associate Directors | 32,000 | 32,000 | 32,000 | 32,000 |
| Clerical Staff | 20,000 | 20,000 | 20,000 | 20,000 |
| Secretaries | 27,000 | 25,200 | 22,500 | 19,800 |
| Subtotal | 121,000 | 119,200 | 116,500 | 113,800 |
| Other | | | | |
| Fringe Benefits | 24,200 | 23,840 | 23,300 | 22,760 |
| Travel | 13,000 | 11,700 | 9,750 | 7,800 |
| Advertising and Promotion | 15,000 | 15,000 | 15,000 | 15,000 |
| Supplies | 3,000 | 2,800 | 2,500 | 2,200 |
| Equipment | 1,000 | 1,000 | 1,000 | 1,000 |
| Total | 177,200 | 173,540 | 168,050 | 162,560 |
| ***Revenue*** | | | | |
| Application Fees | 50,000 | 45,000 | 37,500 | 30,000 |
| Excess of cost over revenue | $127,200 | $128,540 | $130,550 | $132,560 |

Figure C4

**Budget for the Admissions Function**

Fiscal Year 1976-77

| | 1976-77 Budget No. | Amount | Recruiting and Interviewing | Processing Applications | Accepting and Orienting Students | Communications With Students | Administration |
|---|---|---|---|---|---|---|---|
| ***Personnel*** | | | | | | | |
| Director of Admissions | 1 | $ 23,000 | $ — | $ — | $ — | $ — | $23,000 |
| Assistant to the Director | 1 | 19,000 | 9,500 | — | — | — | 9,500 |
| Associate Directors | 2 | 32,000 | 25,600 | — | 6,400 | | — |
| Clerical Staff | 2 | 20,000 | 5,000 | 5,000 | 5,000 | 5,000 | — |
| Secretaries | 3 | 27,000 | — | 4,500 | 4,500 | 9,000 | 9,000 |
| Subtotal | | 121,000 | 40,100 | 9,500 | 15,900 | 14,000 | 41,500 |
| ***Other*** | | | | | | | |
| Fringe Benefits (20 percent) | | 24,200 | 8,020 | 1,900 | 3,180 | 2,800 | 8,300 |
| Travel | | 13,000 | 13,000 | — | — | — | — |
| Advertising and Promotion | | 15,000 | 15,000 | — | — | — | — |
| Supplies | | 3,000 | 500 | 400 | 200 | 1,500 | 400 |
| Equipment | | 1,000 | — | — | — | 600 | 400 |
| Total | | $177,200 | $76,620 | $11,800 | $19,280 | $18,900 | $50,600 |

Figure C5

## Appendix D

# Projecting Mixed Cost

Certain mixed costs can be identified as fixed or variable by examining historical trends, using one or more of the following methods: (1) assignment as fixed or variable, (2) the high-low method, or (3) least squares regression analysis. An academic computer service department is used below to illustrate the procedures involved for each of these methods. The actual expenses of the department for fiscal year 1975-1976 were as follows:

| | |
|---|---|
| Salaries: | |
| Administrator | $ 28,000 |
| Programmers | 108,000 |
| Operators | 120,000 |
| Other | 26,000 |
| Total Salaries | 282,000 |
| Fringe Benefits @ 20 percent | 56,400 |
| Supplies | 75,000 |
| Computer Rental | 87,600 |
| Total | $501,000 |
| Units of usage | 167,000 |
| Rate per unit | $3.00 |

The revenue earned by the department (by internal billings) was $467,600 at a rate of $2.80 per unit. As a result, cost exceeded revenue by $33,400.

The units of computer usage per month and related salaries and wages were as follows:

*Actual Results*
*Fiscal Year 1975-1976*

| Month | Units of Usage | Salaries & Wages |
|---|---|---|
| July | 11,100 | $ 18,600 |
| August | 8,900 | 15,700 |
| September | 12,900 | 21,400 |
| October | 14,100 | 24,000 |
| November | 16,000 | 27,200 |
| December | 14,200 | 23,000 |
| January | 15,100 | 25,700 |
| February | 14,100 | 23,900 |
| March | 19,000 | 32,300 |
| April | 15,400 | 26,200 |
| May | 14,900 | 25,000 |
| June | 11,300 | 19,000 |
| **Total** | 167,000 | $282,000 |

**Method No. 1: Assignment as Fixed or Variable.** Certain mixed costs may appear to remain constant or change in relation to volume. Although not precise, the assumption often made is that mixed cost behavior is either fixed or variable. If it is assumed in the illustration that the cost of salaries and wages is variable, the variable cost per unit would be determined by dividing the total salaries and wages for the year by the total units used for the year. The result would be as follows:

$$\frac{\$282,000}{167,000} = \$1.689 \text{ per unit of usage}$$

By multiplying this cost per unit by the number of units used, the projected amount of salaries and wage cost per month can be determined. The variance that results each month when compared to actual cost is as follows:

***Comparison Based on Assignment as Variable Cost***

| Month | Actual Salaries & Wages | Projected Cost | Variance |
|---|---|---|---|
| July | $18,600 | $18,748 | $(148) |
| August | 15,700 | 15,032 | 668 |
| September | 21,400 | 21,788 | (388) |
| October | 24,000 | 23,815 | 185 |
| November | 27,200 | 27,024 | 176 |
| December | 23,000 | 23,984 | (984) |
| January | 25,700 | 25,504 | 196 |
| February | 23,900 | 23,815 | 85 |
| March | 32,300 | 32,091 | 209 |
| April | 26,200 | 26,011 | 189 |
| May | 25,000 | 25,166 | (166) |
| June | 19,000 | 19,086 | (86) |
| **Total** | $282,000 | | |

**Method No. 2: Application of the High-Low Method.** The high-low method attempts to separate fixed cost from variable cost by assuming that cost at the lowest point is fixed and all cost above this point is variable.

This may be determined as follows:

| | Salaries & Wages | Units of Usage |
|---|---|---|
| High Month (March) | $32,300 | 19,000 |
| Low Month (August) | 15,700 | 8,900 |
| Difference | $16,600 | 10,100 |

(a) Variable Cost: $\frac{\$16,600}{10,100} = \$1.644$

(b) Fixed Cost = Total Cost — Variable Cost
FC = 32,300 — (19,000) (1.644)
FC = 32,300 — 31,236
FC = $1,064

The projected salaries and wages per month are determined by multiplying the variable cost per unit (1.644) by the units of usage and adding the fixed cost. The variance that results when compared to actual salaries and wages is as follows:

***Comparison Based on High-Low Method***

| Month | Actual Salaries & Wages | Projected Cost | Variance |
|---|---|---|---|
| July | $18,600 | $19,312 | $(712) |
| August | 15,700 | 15,696 | 4 |
| September | 21,400 | 22,272 | (872) |
| October | 24,000 | 24,244 | (244) |
| November | 27,200 | 27,368 | (168) |
| December | 23,000 | 24,409 | (1409) |
| January | 25,700 | 25,888 | (188) |
| February | 23,900 | 24,244 | (344) |
| March | 32,300 | 32,300 | — |
| April | 26,200 | 26,382 | (182) |
| May | 25,000 | 25,560 | (560) |
| June | 19,000 | 19,641 | (641) |
| Total | $282,000 | | |

**Method No. 3: Least Squares Regression Analysis.** The least squares method attempts to determine a line that represents the average relationship between salaries and wages and hours of computer usage. The formula for this line of average relationship is as follows:

$y = a + b.$
$a =$ fixed cost
$b =$ variable cost per unit of computer usage

If this were depicted on a graph, *a* would be the height of the line at the *y* intercept while *b* would be the slope of the line. By using the data contained in the example, the value of the constraints *a* and *b* can be found. The slope of the line is determined by applying the following formula:

$$b = \frac{\Sigma x y - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x^2)}{n}}$$

$x =$ units of usage
$y =$ salaries and wages

The calculation of these values, as well as substitution of the values in the formula, appears in Figure D1. The results yield a variable cost of $1.6788 per unit of usage.

Fixed cost is determined by the formula $a = \bar{y} - b\bar{x}$.
$\bar{y}$ (the mean of y) $= 23,500$
$\bar{x}$ (the mean of x) $= 13,917$
$a = 23,500 - (1.6788)\ 13,917$
$a = 23,500 - 23,364$
$a = \$136$

With this information, computer department salaries and wages may be projected by using the following formula:

$\$136 + \$1.6788x =$ Projected Salaries and Wages

By applying this formula to the units of computer usage per month and comparing the results to actual salaries and wages the following variances are determined:

***Comparison Based on Least-Squares Method***

| Month | Actual Salaries & Wages | Projected Cost | Variance |
|---|---|---|---|
| July | $ 18,600 | $18,771 | $(171) |
| August | 15,700 | 15,077 | 623 |
| September | 21,400 | 21,793 | (393) |
| October | 24,000 | 23,807 | 193 |
| November | 27,200 | 26,997 | 203 |
| December | 23,000 | 23,975 | (975) |
| January | 25,700 | 25,486 | 214 |
| February | 23,900 | 23,807 | 93 |
| March | 32,300 | 32,033 | 267 |
| April | 26,200 | 25,990 | 210 |
| May | 25,000 | 25,150 | (150) |
| June | 19,000 | 19,106 | (106) |
| Total | $282,000 | | |

***Comparison of Three Methods***

A comparison of the standard deviations of the variances is a more scientific approach to analysis than comparison of the variances resulting from each method. This comparison is made by completing the following standard deviation formula for each method:

$$\sqrt{\frac{\Sigma\ (\text{Monthly Variances})^2}{12\ \text{Months}}}$$

The calculation of the sum of monthly variances squared appears in Figure D2.

(a) Assignment as variable cost = 388.6
(b) Application of the high-low method = 595.24
(c) Least squares regression analysis = 387.779

Based on this analysis, it appears that the least squares method is the most accurate for projecting future cost consequences because it has the lowest standard deviation. The assignment of all cost as variable is a close second.

Although these statistics represent the behavior of historical cost and revenue to volume, they provide some basis for projecting economic performance in the future based on expected levels of volume. Naturally, the fixed and variable components of cost may require adjustment to reflect significant changes in environmental conditions and management decisions.

***Applicability of Methods for Separating Mixed Cost***

Theoretically, the methods of separating mixed cost and revenue may be used for projecting the economic performance of all organizational units within institutions of higher education. Their applicability in academic departments is, however, somewhat limited. Most academic department costs relate to instructional services or to the conduct of research

and public service activities. In the former case, volume data in terms of student credit hours are available for each semester. In many institutions there are only two or three terms per academic year, so that several years of experience would have to be considered in order to use these methods. Also, certain elements of academic department cost and revenue are quite dynamic in terms of changes in educational policy and procedure, all of which significantly influence changes in the behavior of cost and revenue in the future.

Clearly, historical average variable cost and revenue may be expected to change dramatically with changes in administrative decisions and environmental factors. In research and public service activities, the level of activity is often directly dependent on third parties. Thus, the level of funding available and related costs that may be expected are often outside the control of the academic department and the institution and tend to vary with changes in the economy and the priorities of governmental bodies. Changes in the level of outside financing can also directly influence instructional cost, since a decrease in outside funding may require that the instructional budget absorb faculty with contractual commitments. Thus, an analysis of *past* cost and revenue behavior for projecting future economic consequences in the academic department may produce invalid results should conditions change.

There may be opportunities, however, to apply these methods when projecting other academic department costs and revenues. They would be applicable when fixed and variable behavior of cost and revenue is influenced only slightly by institutional decisions or the environment. For instance, if supply cost historically varied irregularly with student credit hours (which was determined by one of these methods), the results of the analysis of past cost behavior might be used to project future cost.

Because an analysis of past behavior is of limited value for certain academic department costs and revenues, another method of projection is required. This method relies on an identification of the primary factors that will influence the cost of a particular activity in the department. Computer-based mathematical models, such as the simulation model described in Section 5 of this report, can assist the planner in complex projections of costs and revenues.

**Calculation of Variable Cost Per Hour of Computer Usage** — **Figure D1**

| Month | Units of Usage x (in 1,000s) | Salaries and Wages y (in 1,000s) | Units of Usage times Salaries + Wages xy | Units of Usage Squared $x^2$ |
|---|---|---|---|---|
| July | 11.1 | $ 18.6 | 206.46 | 123.21 |
| August | 8.9 | 15.7 | 139.73 | 79.21 |
| September | 12.9 | 21.4 | 276.06 | 166.41 |
| October | 14.1 | 24.0 | 338.4 | 198.81 |
| November | 16.0 | 27.2 | 435.2 | 256.0 |
| December | 14.2 | 23.0 | 326.6 | 201.64 |
| January | 15.1 | 25.7 | 388.07 | 228.01 |
| February | 14.1 | 23.9 | 336.99 | 198.81 |
| March | 19.0 | 32.3 | 613.7 | 361.0 |
| April | 15.4 | 26.2 | 403.48 | 237.16 |
| May | 14.9 | 25.0 | 372.5 | 222.01 |
| June | 11.3 | 19.0 | 214.7 | 127.69 |
| **Total** | 167.0 | $282.0 | 4,051.89 | 2,399.96 |

$$(1)\quad b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x^2)}{n}}$$

$$(2)\quad b = \frac{4051.89 - \frac{(167)(282)}{12}}{2399.96 - \frac{(167)^2}{12}}$$

$$(3)\quad b = \frac{4051.89 - 3924.5}{2399.96 - 2324.08}$$

$$(4)\quad b = \frac{127.39}{75.88} = \$1.6788 \text{ per unit of usage}$$

**Calculation of the**
**(Monthly Variances)²**

**Figure D2**

| Month | Variable Cost Variance | Variable Cost $V^2$ | High Low Variance | High Low $V^2$ | Least Squares Variance | Least Squares $V^2$ |
|---|---|---|---|---|---|---|
| July | $(148) | $ 21,904 | $(712) | $506,944 | $(171) | $ 29,241 |
| August | 668 | 446,224 | 4 | 16 | 623 | 388,129 |
| September | (388) | 150,544 | (872) | 760,384 | (393) | 154,449 |
| October | 185 | 34,225 | (244) | 59,536 | 193 | 37,249 |
| November | 176 | 30,976 | (168) | 28,224 | 203 | 41,209 |
| December | (984) | 968,256 | (1409) | 1,985,281 | (975) | 950,625 |
| January | 196 | 38,416 | (188) | 35,344 | 214 | 45,796 |
| February | 85 | 7,225 | (344) | 118,336 | 93 | 8,649 |
| March | 209 | 43,681 | — | — | 267 | 71,289 |
| April | 189 | 35,721 | (182) | 33,124 | 210 | 44,100 |
| May | (166) | 27,556 | (560) | 313,600 | (150) | 22,500 |
| June | 86 | 7,396 | (641) | 410,881 | (106) | 11,236 |
| **Total** | | $1,812,124 | | $4,251,670 | | $1,804,472 |

$$\sqrt{\frac{\Sigma V^2}{12}}$$

388.6 **Variable Cost**

= 595.24 **High Low**

387.779 **Least Squares**

Appendix E

# Projecting Cost and Revenue for More Than One Department

Changes in student demand in one academic department can have multiple cost and revenue implications for other academic departments. For instance, if students taking electives in one department change their typical pattern of choice by selecting the course offerings of another department, the latter department may be required to open new sections and to hire additional faculty members, while the former department may have to fill classes with other students or eliminate offerings and faculty members to reduce cost. A similar situation occurs when academic departments experience increases or decreases in student majors. Regardless of whether the changes in student demand are caused by institutional decisions or result from student choice, the cost effect of those changes must be determined for all academic departments. Thus, in preparing projections, an administrator who anticipates fluctuations in majors in a particular field of study must consider the economic implications not only for the major department but also for academic departments providing service courses to students in fulfillment of their various degree requirements.

The application of this type of cost projection can be illustrated by the case of a department of engineering which offers a bachelor of science degree in a field of engineering science. To receive a degree in this field of specialization, students must complete course work in the following areas:

| | Credits |
|---|---|
| Engineering | 51 |
| Mathematics | 21 |
| Humanities | 30 |
| Chemistry | 6 |
| Physics | 12 |
| | 120 |

In the example, 360 student majors in engineering science, along with other student majors, were enrolled in engineering courses to complete their degree requirements. In examining the course prerequisites and typical pattern of enrollment of engineering science majors, the analyst determined that engineering students complete their degree requirements as indicated in Figure E1, which shows that the 360 engineering science majors cause a demand for 4,428 student credit hours (SCHs) of instruction in the engineering department as well as instruction in the following areas:

| | SCHs of Instruction |
|---|---|
| Mathematics | 2,160 |
| Humanities | 2,556 |
| Chemistry | 792 |
| Physics | 864 |
| Total service department instruction | 6,372 |

Engineering science majors receive approximately 1.44 SCHs of instruction in service departments for every SCH of instruction received in engineering. Thus, a change in the number of engineering science majors will affect the hours of instruction provided by other departments.

The effect of this demand on faculty requirements of service departments can be seen by focusing on the activities of the mathematics department. This department provides instruction to mathematics majors and others as well as the 2,160 SCHs required to satisfy the degree requirements of engineering science majors. A capsule view of this department's faculty complement and activities follows:

*Mathematics Department (Present Condition)*

| Function | SCHs: Math Majors and Others | SCHs: Engineering Majors | SCHs: Total | Students Enrolled in Courses | Pref. Section Size | No. of Sections Required[1] | No. of Faculty @ 8 Per[2] |
|---|---|---|---|---|---|---|---|
| Instruction: | | | | | | | |
| Freshmen | 2,202 | 1,188 | 3,390 | 1,130 | 15 | 75 | 9.375 |
| Sophomores | 1,401 | 576 | 1,977 | 659 | 15 | 44 | 5.5 |
| Juniors | 1,101 | 216 | 1,317 | 439 | 10 | 44 | 5.5 |
| Seniors | 801 | 180 | 981 | 327 | 10 | 33 | 4.125 |
| **Total** | 5,505 | 2,160 | 7,665 | 2,555 | | 196 | 24.5 |
| Departmental Administration | | | | | | | 1.5 |
| Sponsored Research | | | | | | | 8. |
| Total Faculty | | | | | | | 34. |

*Notes:*
[1] Rounded to nearest section
[2] Faculty workload 24 credits per year or 8 sections (3 credits per section)

Should the institution project a change in engineering science majors, a change in SCHs of instruction required may be expected in the mathematics department. For instance, if engineering science majors were to increase by 68 students, going from the present complement of 360 students to 428, or if engineering science majors were to decrease by 68, to 292, such changes would affect the student semester hours for the mathematics department and other service departments, as indicated on Figure E2. Such changes in student demand for SCHs of instruction would in turn influence the number of faculty required for instruction in service departments.

In situation 1, where the number of engineering science majors is expected to increase by 68, the mathematics department will be required to open nine additional sections. This will necessitate the services of 1.125 additional faculty members.

*Mathematics Department (Situation 1)*

| Function | SCHs: Math Majors and Others | SCHs: Engineering Majors | SCHs: Total | Students Enrolled in Courses | Pref. Section Size | No. of Sections Required[1] | No. of Faculty @ 8 Per[2] |
|---|---|---|---|---|---|---|---|
| Instruction: | | | | | | | |
| Freshmen | 2,202 | 1,404 | 3,606 | 1,202 | 15 | 80 | 10. |
| Sophomores | 1,401 | 684 | 2,085 | 695 | 15 | 46 | 5.75 |
| Juniors | 1,101 | 258 | 1,359 | 453 | 10 | 45 | 5.625 |
| Seniors | 801 | 216 | 1,017 | 339 | 10 | 34 | 4.25 |
| **Total** | 5,505 | 2,562 | 8,067 | 2,689 | | 205 | 25.625 |
| Departmental Administration | | | | | | | 1.5 |
| Sponsored Research | | | | | | | 8. |
| Total | | | | | | | 35.125 |

Should the number of engineering science student majors decrease by 68 to 292, as is projected in situation 2, the mathematics department will be required to teach eight fewer sections. This will necessitate reducing the complement of faculty in the mathematics department by one.

*Notes:*
[1] Rounded to nearest section
[2] Faculty workload 24 credits per year or 8 sections (3 credits per section)

*Mathematics Department (Situation 2)*

| Function | SCHs: Math Majors and Others | SCHs: Engineering Majors | SCHs: Total | Students Enrolled in Courses | Pref. Section Size | No. of Sections Required[1] | No. of Faculty @ 8 Per[2] |
|---|---|---|---|---|---|---|---|
| Instruction: | | | | | | | |
| Freshmen | 2,202 | 972 | 3,174 | 1,058 | 15 | 71 | 8.875 |
| Sophomores | 1,401 | 468 | 1,869 | 623 | 15 | 42 | 5.25 |
| Juniors | 1,101 | 174 | 1,275 | 425 | 10 | 43 | 5.375 |
| Seniors | 801 | 144 | 945 | 315 | 10 | 32 | 4. |
| **Total** | 5,505 | 1,758 | 7,263 | 2,421 | | 188 | 23.5 |
| Departmental Administration | | | | | | | 1.5 |
| Sponsored Research | | | | | | | 8. |
| Total | | | | | | | 33. |

These examples highlight the point that changes in environmental and decision factors will influence cost (and revenue). Changing conditions in one department can have dynamic and far-reaching consequences for related academic service departments. Administrators must be able to examine these dynamic conditions and their projected cost and revenue implications when making decisions about the use of faculty, staff, and other resources.

*Notes:*

(1) Rounded to nearest section

(2) Faculty workload 24 credits per year or 8 sections (3 credits per section)

---

**Distribution of Engineering Science Major Student Credit Hours**
**Typical Enrollment Pattern**

**Figure E1**

| | Number of Engineering Science Majors | Engineering: SCHs Per Stu. | Engineering: SCHs | Mathematics: SCHs Per Stu. | Mathematics: SCHs | Humanities: SCHs Per Stu. | Humanities: SCHs | Chemistry: SCHs Per Stu. | Chemistry: SCHs | Physics: SCHs Per Stu. | Physics: SCHs | Total: SCHs Per Stu. | Total: SCHs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Freshmen** | 132 | 9 | 1,188 | 9 | 1,188 | 6 | 792 | 6 | 792 | | | 30 | 3,960 |
| **Sophomores** | 96 | 15 | 1,440 | 6 | 576 | 6 | 576 | | | 3 | 288 | 30 | 2,880 |
| **Juniors** | 72 | 15 | 1,080 | 3 | 216 | 9 | 648 | | | 3 | 216 | 30 | 2,160 |
| **Seniors** | 60 | 12 | 720 | 3 | 180 | 9 | 540 | | | 6 | 360 | 30 | 1,800 |
| | 360 | 51 | | 21 | | 30 | | 6 | | 12 | | 120 | |
| **Total Engineering Science Major SCHs** | | | 4,428 | | 2,160 | | 2,556 | | 792 | | 864 | | 10,800 |
| **SCHs of students taking engineering as service courses** | | | 732 | | | | | | | | | | |
| **Total Student Credit Hours** | | | 5,160 | | | | | | | | | | |

**Projected Distribution of Engineering Science Major**
**Student Credit Hours**
**Based on a Predicted Change in the Number of Majors**

**Situation 1:** Total engineering student credit hours increased by expanding the engineering program by 68 students to 428 engineering science majors

| | Number of Engineering Science Majors | Engineering SCHs Per Stu. | Engineering SCHs | Mathematics SCHs Per Stu. | Mathematics SCHs | Humanities SCHs Per Stu. | Humanities SCHs | Chemistry SCHs Per Stu. | Chemistry SCHs | Physics SCHs Per Stu. | Physics SCHs | Total SCHs Per Stu. | Total SCHs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Freshmen | 156 | 9 | 1,404 | 9 | 1,404 | 6 | 936 | 6 | 936 | | | 30 | 4,680 |
| Sophomores | 114 | 15 | 1,710 | 6 | 684 | 6 | 684 | | | 3 | 342 | 30 | 3,420 |
| Juniors | 86 | 15 | 1,290 | 3 | 258 | 9 | 774 | | | 3 | 258 | 30 | 2,580 |
| Seniors | 72 | 12 | 864 | 3 | 216 | 9 | 648 | | | 6 | 432 | 30 | 2,160 |
| | 428 | 51 | | 21 | | 30 | | 6 | | 12 | | 120 | |
| Total Engineering Science Major SCHs | | | 5,268 | | 2,562 | | 3,042 | | 936 | | 1,032 | | 12,840 |
| SCHs of students taking engineering as service courses | | | 732 | | | | | | | | | | |
| **Total Student Credit Hours** | | | 6,000 | | | | | | | | | | |

**Situation 2:** Total engineering student credit hours decreased as a result of a decline of 68 students to 292 engineering science majors

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Freshmen | 108 | 9 | 972 | 9 | 972 | 6 | 648 | 6 | 648 | | | 30 | 3,240 |
| Sophomores | 78 | 15 | 1,170 | 6 | 468 | 6 | 468 | | | 3 | 234 | 30 | 2,340 |
| Juniors | 58 | 15 | 870 | 3 | 174 | 9 | 522 | | | 3 | 174 | 30 | 1,740 |
| Seniors | 48 | 12 | 576 | 3 | 144 | 9 | 432 | | | 6 | 288 | 30 | 1,440 |
| | 292 | 51 | | 21 | | 30 | | 6 | | 12 | | 120 | |
| Total Engineering Science Major SCHs | | | 3,588 | | 1,758 | | 2,070 | | 648 | | 696 | | 8,760 |
| SCHs of students taking engineering as service courses | | | 732 | | | | | | | | | | |
| **Total Student Credit Hours** | | | 4,320 | | | | | | | | | | |

**Figure E2**

## Appendix F

# Cost and Revenue Analysis

There are two primary types of cost and revenue analysis that use variable, fixed, and mixed costs and revenues to examine the future consequences of decisions affecting resources: cost-volume-revenue analysis and differential cost and revenue analysis. These types of analyses are described below along with specific illustrations of how they may be used by institutions of higher education.

### *Cost-Volume-Revenue Analysis*

Cost-volume-revenue analysis permits planners to examine how volume will affect cost and revenue. One element in cost-volume-revenue analysis is called the breakeven point — the point at which total cost equals total revenue.

Cost-volume-revenue analysis may be illustrated by a middle-income tuition-remission plan being considered by an institution. The institution wants to turn around a declining enrollment situation by providing access to a portion of the population excluded from various forms of aid, students from families with annual incomes of $10,000 to $16,000. Before the tuition-remission plan was considered, cost exceeded revenue by $400,000.

The projected amount of remission per student was determined as follows:

| | | |
|---|---|---|
| Tuition per year | | $3,000 |
| Less: Student loans | $1,300 | |
| BEOG | 400 | |
| Personal funds | 300 | |
| Net revenue | | 2,000 |
| Tuition remission per student | | $1,000 |

This plan is expected to increase full-time equivalent students by as much as 500 over the present full-time equivalent enrollment of 4,000. By analysis of the type of student majors that may be expected and the distribution of courses and sections that will be required to serve these students, it is projected that the fixed cost will remain at the level of $9,000,000 and that variable cost will increase from $3,400,000 at $1,000 per student.

From these facts the breakeven point can be calculated to determine the number of students required to have cost and revenue in equilibrium. The breakeven equation is as follows:

Revenue = Variable Cost + Fixed Cost + Gain − Loss

Let $x$ represent the number of additional tuition-remission students that are required to break even.

| Revenue | = | Variable Cost | + Fixed Cost + | Gain-Loss |
|---|---|---|---|---|
| $12{,}000{,}000 + 2{,}000x$ | = | $3{,}400{,}000 + 1{,}000x$ | $+ 9{,}000{,}000 +$ | 0 |
| $2{,}000x$ | | $- 1{,}000x = 3{,}400{,}000 + 9{,}000{,}000 - 12{,}000{,}000$ | | |
| | | $1{,}000x = 400{,}000$ | | |
| | | $x = 400$ additional students required to break even | | |

The breakeven equation might be looked at another way, in terms of the *contribution* made in additional revenue or additional expenses, which could be used to offset fixed cost. This may be displayed as follows:

*Contribution before tuition remission plan:*

| | |
|---|---|
| Revenue for 4,000 students | $12,000,000 |
| Variable cost | 3,400,000 |
| Contribution to cover fixed cost | $ 8,600,000 |

*Contribution per student as a result of tuition-remission plan:*

| Revenue per student | − | Variable cost per student | = | Contribution per student |
|---|---|---|---|---|
| $2,000 | | $1,000 | | $1,000 |

*Contribution Equation:*

$$\frac{\text{Fixed cost} - \text{Contribution before tuition remission} + \text{Gain or loss}}{\text{Contribution per student}}$$

$$\frac{9{,}000{,}000 - 8{,}600{,}000 + 0}{1{,}000}$$

$$\frac{400{,}000}{1{,}000} = 400 \text{ additional students required to break even}$$

Often the revenue that should be earned at the breakeven point cannot be determined because the number of units is not available. When this happens, the *contribution margin rates* approach may be used to determine breakeven revenue. The ratio is developed by dividing variable cost per student, which is $1,000, by revenue per student of $2,000, which would equal 50 percent.

$$\text{Breakeven revenue} = \frac{\text{Fixed cost — contribution before tuition remission + Gain or loss}}{\text{Contribution margin ratio}} + \text{Present tuition revenue}$$

$$\text{Breakeven revenue} = \frac{9{,}000{,}000 - 8{,}600{,}000 + 0}{50\%} + 12{,}000{,}000$$

$$\text{Breakeven revenue} = \frac{400{,}000 + 12{,}000{,}000}{.50}$$

$$\text{Breakeven revenue} = 12{,}800{,}000$$

The relationship of cost to volume to revenue may be shown on a cost-volume-revenue chart, such as Figure F1. It indicates the breakeven point and the loss and gain that might occur under the middle-income tuition-remission plan. If no action is taken on the plan and the current enrollment of 4,000 students is maintained with no other actions to increase revenue and reduce cost, a $400,000 loss may be expected. By adopting the plan, the institution will be able to reduce the projected $400,000 loss with every new student enrolled.

Cost-volume-revenue analysis may also be used to determine the number of students required to achieve a desired level of gain or loss. For instance, if a gain of $220,000 is necessary to offset prior years' losses, the number of students required, assuming all other conditions remain constant, would be determined as follows:

| Revenue | = | Variable Cost | + | Fixed Cost | + | Gain |
|---|---|---|---|---|---|---|
| 12,000,000 + 2,000x | = | 3,400,000 + 1,000x | + | 9,000,000 | + | 220,000 |
| 2,000x | − | 1,000x | = | 3,400,000 + 9,000,000 | + | 220,000 − 12,000,000 |
| | | 1,000x | = | 620,000 | | |

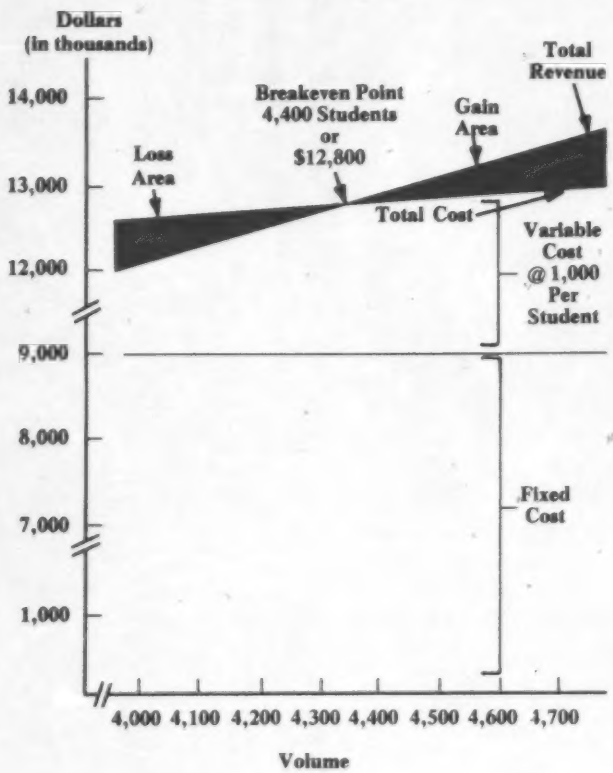
x = 620 additional students to achieve a gain of $220,000

Cost-volume-revenue analysis assumes that the following conditions exist:

1. Cost behavior can be analyzed to distinguish fixed and variable costs.
2. Fixed cost will be unchanged over levels of volume being considered.
3. Variable cost will change proportionately to changes in levels of volume being considered.
4. Cost and revenue will follow a linear pattern over the levels of volume being considered.
5. Efficiency and productivity are to remain the same.
6. The major factor affecting cost and revenue is a shift in volume.

Figure F-1

**Cost-Volume-Revenue Chart**




Because these assumptions are not always true, care must be exercised in using the results. Planners and analysts must determine whether variations from these assumptions are likely to be significant enough to result in misleading data. Because this judgment is one of materiality, it must be made on a case-by-case basis rather than applying a general rule.

### *Differential Cost and Revenue Analysis (Single Course of Action)*

Differential cost and revenue represent the change in total cost and revenue resulting from the addition, elimination, or modification of activities. Differential cost is also called incremental cost when additional cost is anticipated; it is called escapable cost when a contraction in cost is projected because of retrenchment. Differential cost and revenue should not be confused with marginal cost and revenue, the added cost and revenue applicable to *one* additional unit of service.

Differential cost and revenue analysis is a variation of cost-volume-revenue analysis. Differential analysis, however, focuses on those costs and revenues that will be changed should the course of action being considered be adopted. These costs and revenues are the relevant economic results that are projected.

Differential analysis may be illustrated by the case of an institution that is seeking funds to establish an endowed chair in environmental science. The immediate question facing the president is what size of an endowment will be necessary to establish the endowed chair. The institution's budget analyst first attempted to determine, on the basis of the following information, the full cost attributable to establishing this chair:

- The endowed chair would be given to a distinguished senior faculty member in the institution. The faculty member would be expected to provide 6 semester credit hours of instruction and would have released time to conduct separately budgeted research for the equivalent remaining time of 18 semester credit hours. In essence, the chair would require 25 percent effort in teaching and 75 percent in research.

- The hours of instruction given up by this senior faculty member would be taught by a full-time associate professor, who would be added to the faculty at a salary of $16,000.

The budget analyst determined that the full cost attributable to the endowed chair would be as follows:

| | |
|---|---|
| Salary-senior faculty member | $24,000 |
| Fringe benefits @ 20 percent | 4,800 |
| Supplies for research | 800 |
| Equipment for research | 4,000 |
| Travel for research | 3,000 |
| | 36,600 |
| Indirect Costs — Department (all fixed) | 800 |
| — Institution (all fixed) | 14,600 |
| | $52,000 |

Based on this analysis, the budget analyst determined that if the endowment portfolio continued to earn 5 percent, a gift of $1,040,000 would be required to establish the endowed chair ($52,000 ÷ .05 = $1,040,000).

In this example the assumption is that all indirect cost is fixed, although this would not always be the case.

Recognizing that the magnitude of this amount made such a gift unlikely, the president asked the budget analyst to

determine the incremental or additional cost that might be expected by establishing the endowed chair. This calculation would indicate the minimum endowment gift required.

The analyst calculated this projected additional cost as follows by using differential cost analysis:

| | |
|---|---|
| Associate professor | $16,000 |
| Fringe benefits @ 20 percent | 3,200 |
| Supplies for research | 800 |
| Equipment for research | 4,000 |
| Travel for research | 3,000 |
| | $27,000 |

The minimum endowment fund required to finance at least the incremental cost of the environmental science chair is $540,000 ($27,000 ÷ .05). However, since fixed cost must be financed ultimately from some source, a required endowment fund of between $540,000 and $1,040,000 would provide a contribution to such financing.

### *Differential Cost and Revenue Analysis (Multiple Courses of Action)*

Differential analysis is most useful for comparing the economic benefits of one alternative with those of another. In this analysis the net contribution of revenue over cost is measured to determine the projected contribution that each alternative can make to offsetting fixed cost.

The use of differential analysis to evaluate multiple courses of action can be illustrated by the case of an institution that is considering establishing a journalism program. Based on an analysis of student preference (demand), other schools providing this program in the geographical area served by the school (competition), and employment possibilities upon graduation (supply), two alternatives appear feasible: (1) establishing a new journalism program that would be completely self-contained within the school; or (2) establishing a new journalism program that would be affiliated with another institution that already has a nationally recognized program.

*Alternative 1.* By examining the market potential, the analyst projects an enrollment of 200 full-time equivalent students in this journalism program. This would require establishing a journalism department with one department chairperson, two full professors, four associate professors, and one secretary. A budget for supplies, equipment, and travel would also be required. No additional physical plant would be necessary.

Additional cost would be incurred in other academic departments providing service courses to journalism majors. General support cost for admissions, registrar, library, and other functions might also increase.

By analyzing the cost behavior patterns of each department, the analyst calculates the following incremental cost and revenue for alternative No. 1:

| | | |
|---|---|---|
| (1) Journalism Department: | | |
| Academic salaries | | $120,000 |
| Secretarial cost | | 8,000 |
| Fringe benefits @ 20 percent | | 25,600 |
| Supplies, equipment, and travel | | 9,400 |
| | | 163,000 |
| (2) Incremental Cost of Academic Service Departments: | | |
| Academic salaries | | 166,500 |
| Secretarial cost | | 25,000 |
| Fringe benefits @ 20 percent | | 38,300 |
| Supplies, equipment and travel | | 35,000 |
| | | 264,800 |
| (3) Incremental General Support Cost | | 50,000 |
| Total Incremental Cost | | 477,800 |
| (4) Incremental Revenue: | | |
| Journalism department | 155,000 | |
| Service departments | 445,500 | 600,500 |
| Excess of incremental revenue over incremental cost | | $122,700 |

*Alternative 2.* Under this alternative, the analyst projects that 100 students will enroll in the journalism program. It is assumed that fewer students would enroll in this program than in alternative No. 1 because it is academically less attractive. The program would require a part-time coordinator and a full-time secretary. Fringe benefits, supplies, equipment, and recruitment costs would also be required.

Additional cost would be incurred in academic departments providing service courses and in general support areas of the institution.

It is assumed that the $100 per credit hour received from students would be forwarded to the affiliated institution for all credit hours taught by that institution.

An analysis of the cost behavior patterns of the departments affected by the influx of journalism majors provides the following incremental cost and revenue for alternative No. 2:

| | |
|---|---|
| (1) Journalism Department: | |
| Academic salaries (coordinator ½ time) | $12,000 |
| Secretarial cost | 8,000 |
| Fringe benefits @ 20 percent | 4,000 |
| Supplies, equipment, and recruitment | 3,000 |
| | 27,000 |
| (2) Incremental Cost of Academic Service Departments: | |
| Academic salaries | 85,500 |
| Secretarial cost | 12,800 |
| Fringe benefits @ 20 percent | 19,700 |
| Supplies, equipment, and travel | 15,000 |
| | 133,000 |

| | |
|---|---|
| (3) Incremental General Support Cost | 25,000 |
| Total Incremental Cost | 185,000 |
| (4) Incremental Revenue: | |
| Service departments | 225,000 |
| Excess of incremental revenue over incremental cost | $ 40,000 |

*Comparison of Alternatives.* A comparison of the alternatives shows that alternative No. 1 will provide $82,700 more incremental revenue than alternative No. 2 ($122,700 − 40,000 = 82,700). A key simplifying assumption made in this example was that the new program would not affect demand for other programs such that the enrollment in these programs would be reduced by changes in student preference for journalism. If such shifts were to occur, incremental revenue would be somewhat less than indicated.

The analysis should not end here. Rather, cost-volume-revenue analyses or breakeven analyses should be performed to determine the effect on cost and revenue at various levels of student enrollment for both alternatives. These analyses will indicate the minimum number of students required to make the program successful in economic terms. The program planners should also consider how long it will take to achieve full projected enrollment. This finding will indicate the amount of exposure or risk facing the institution under each alternative.

**Appendix G**

# Bibliography

Following is a bibliography of the sources researched in developing the findings in this report. The authors are particularly indebted to two sources, Charles T. Horngren's *Cost Accounting: A Managerial Emphasis* and Joel Dean's *Managerial Economics.* Both books are classics in the field of cost behavior analysis and proved helpful in the authors' efforts to relate the concepts used by commercial enterprises to institutions of higher education.

Special mention is also made of an article written by Vincent R. LoCascio entitled "A Computer Simulation Model for Colleges and Universities." The authors, with permission, adapted this article to form Section 5.

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